PHYTOPATHOLOGY

VOLUME XV NUMBER 10

OCTOBER, 1925

CONDITIONS ANTECEDENT TO THE INFECTION OF WHITE PINES BY CRONARTIUM RIBICOLA IN THE NORTH-EASTERN UNITED STATES

PERLEY SPAULDING AND ANNIE RATHBUN-GRAVATT

WITH FIVE FIGURES IN THE TEXT

Investigations of *Cronartium ribicola* Fischer by the writers during the past few years have yielded a number of random notes on the conditions antecedent to the infection of white pines by this fungus in the Northeastern United States. As none of these observations fitted into any other article prepared for publication, they have been collected in the present one.

FACTORS INFLUENCING THE PERIOD OF PRODUCTION OF THE TELIA

In 1922 Spaulding (6) published the available data on the time of the formation of the first telia of *Cronartium ribicola* in infected areas of the Northeastern United States and Europe. These dates may be, and usually are, quite different from those for the formation of telia in abundance in the same localities, as it commonly takes about two weeks or more for their abundant development to take place. For example, near Warrensburg, New York, in 1923, telia were not abundant until the latter part of July, and in 1924, not until the first of August. Yet, in both years the first telia were formed about July 4. While the weather conditions somewhat retard or accelerate the formation of the first telia, they seem to have a more potent influence upon the formation of the telia in abundance. The season of the production of the telia lasts from the formation of the first ones until the fall of the leaves of their *Ribes* hosts. This latter date varies with the species of *Ribes* and the weather conditions of the latter part of the season. Drought in August or later is quite sure to cause the fall of practically all of the leaves of such species as *R. cynosbati* (L.) Mill., *R. glandulosum* Grauer, and *R. rotundifolium* Michx. The premature fall of infected leaves is hastened further by the action of the blister rust fungus. Also the *Ribes* species vary in the time of season when they normally drop their leaves; some ripen them and prepare for winter rest earlier than others. *R. cynosbati*, *R. glandulosum*, and *R. rotundifolium* are not only especially affected

by drought and by blister rust attacks but they also, together with *R. vulgare* Lam., normally shed their leaves early. *R. nigrum* L. and *R. odoratum* Wendl. are examples of species which retain their leaves for a maximum time. Species of *Ribes* also differ much in their ability to continue producing new leaves throughout the season, and in their ability to produce a second crop of leaves after premature defoliation. *R. glandulosum* does not commonly form a second crop of leaves after defoliation, while *R. nigrum* usually continues to form new leaves throughout the season. The other northeastern species of *Ribes* are intermediate between these two in their leaf-producing ability.

FACTORS INFLUENCING THE GERMINATION OF TELIOSPORES

Newly matured teliospores of *Cronartium ribicola* appear to germinate with equal vigor regardless of the species of *Ribes* upon which they are produced. Practically every teliospore of newly and fully matured telial columns has been seen to germinate naturally when floating upon the surface of water. In the northeastern United States it is probable that comparatively few teliospores fail to produce sporidia sometime before they lose their viability. The climate in those regions where this fungus is now spreading naturally is such that moisture in some form apparently reaches most of the telia in sufficient quantities to cause the teliospores to germinate before they lose viability. Moisture seems to be the prime requisite for the germination of the teliospores. Temperature *per se* does not seem so important in limiting their germination. Low temperatures are definitely known not to prevent germination, as teliospores have been found profusely germinating upon leaves lying upon melting snow (7). Moreover, they have been germinated by the writers at out-door temperatures from August 1 to November 8 (7, 8). No test has been made of the effect of high temperatures upon germination of the teliospores, although Doran's (4) tests with the aeciospores and urediniospores of this fungus would indicate that the higher summer temperatures may prevent germination even in the presence of water. The effect of high summer temperatures may be due more to the accompanying dryness than to the heat alone. Definite tests are needed to determine the facts.

The oldest teliospores in a telial column are located at its tip, while the youngest ones are at its base (3, 11). The oldest teliospores germinate first. Immature columns are shorter than mature ones. When immature columns were placed under conditions favorable for germination in our cultures, only the teliospores at their tips germinated. This reaction has been well illustrated by Tulasne (11) for *Cronartium asclepiadeum* Willd., in one of the earliest figures ever published of germinating teliospores of a *Cronar-*

tium. The length and diameter of the mature telial columns of *C. ribicola* vary with the host species upon which they are borne (6, 10). Those borne upon leaves of *Ribes glandulosum* are longer and more slender than those upon most of the other species of *Ribes* found in the Northeastern United States.

Each cell of a telial column (each teliospore) germinates independently of the rest. Physiologically it is as much a separate entity as though it actually were separate morphologically, as, for instance, the aeciospores or urediniospores of this fungus. After a teliospore has completely germinated, nothing is left of the original spore except an empty shell. When the tip teliospores of a column have germinated, the empty cells fall apart readily and are commonly infested by numerous saprophytic fungi such as *Alternaria*, etc. The exhausted cells appear to be much more readily penetrated by water than are the ungerminated ones. While some of the inner teliospores of a column undoubtedly germinate when the outermost ones do (3) it is a question whether many of them do so until the outer ones have germinated and their empty shells have been sloughed off. Reed and Crabill (5) found that this happens with the teliospores of *Gymnosporangium juniperi-virginianae* Schw., which are borne in elongate protuberances somewhat similar to the columns of *Cronartium ribicola*. When inner teliospores of *C. ribicola* do germinate with the outer ones, they are able to push their germ tubes between the overlying ones and form their promycelia on the outside of the column. This undoubtedly is much more easily done when the outer cells are empty and fall apart more readily.

The time required for the germination of teliospores varies considerably with conditions. York[1] found that they germinated readily and copiously at 75° F. in six hours, if tested when fresh and if they are not formed in droughty weather. General experience has shown that they are injured by drought if it occurs at the time of, or immediately after, their formation. The writers found that, at temperatures of 55–70° F., fresh teliospores germinated and formed sporidia in maximum numbers in about 12 hours (8). If the telia-bearing *Ribes* leaves were kept air-dried and lying loose in papers as botanical specimens are usually kept, numerous tests showed that the time for germination and the production of sporidia increased directly with the increase in time of storage. Repeated weekly tests showed that this was also true for teliospores kept out-of-doors exposed to wind and rain (8).

The number of telia, and consequently of teliospores and of sporidia, produced by a given unit of leaf area varies greatly with the different species of *Ribes*, as was shown by Taylor (10). In this respect *R. nigrum* far surpasses all other species of *Ribes* found in the Northeastern United

[1] Communicated orally.

States. This, rather than greater viability of sporidia produced upon it, may explain why this species causes relatively heavy infection of pines. The number of sporidia produced at a given source directly controls their abundance at given distances from this source, as can be shown by well known mathematical formulae. The frequency of their occurrence at a given distance from their source has a direct effect upon the number of pine infections caused by them. This is shown by the fact that frequency of pine infections decreases with increase in distance from the source of sporidia.

FACTORS INFLUENCING THE LONGEVITY OF TELIOSPORES

The length of time a given collection of telial columns continues to contain germinable teliospores can be tested in two ways: (1) by storing the columns in an air dry condition, or (2) by storing them out-of-doors under conditions which simulate the natural ones. Telial columns should be tested for germination at frequent intervals by "floating" on water or by placing in moist chambers (7, 8). The first method of storing gives a simple test of loss of viability while the second method involves both a test of loss of viability and a test of the rate at which the teliospores germinate under natural conditions. In the latter method the effects of the two factors can not be separated. In nature the telial columns would be subjected to conditions which approximate those of the second method of storage. In this paper "longevity" is expressed in terms of time during which there remained ungerminated and still viable teliospores. When stored out-of-doors in mosquito netting bags, the longevity of different collections of teliospores varied from about 3 weeks to about 3 months (7, 8). Under these conditions the longevity of teliospores on naturally fallen leaves collected from the ground was approximately the same as that of those on leaves collected at the same time from *Ribes* bushes. The casting of infected *Ribes* leaves did not shorten the longevity of the teliospores when they were stored under artificial conditions, and apparently did not decrease the number of sporidia produced by them. As a matter of fact, the teliospores on leaves lying on the surface of the soil would be in a more favorable position for the production of sporidia than those on leaves still attached to the bush, because moisture might reach the telia more readily on the soil. This is especially true in a time of drought, as the fallen leaves would be more easily moistened by dew. In the case of a swamp-inhabiting *Ribes*, the fallen leaves would be moist at times when the leaves on the bushes were still dry. However, the length of time that they would bear germinable teliospores would be shortened by the conditions favoring early germination and exhaustion of the teliospores.

An important factor controlling the longevity of teliospores upon leaves killed by frost or fallen to the ground is the character of the leaf upon

which they are borne. This was observed distinctly with the material exposed by us to the weather in our tests of the longevity of teliospores (7, 8). The leaves of *R. nigrum* remained firm and in good condition the longest of any of the eight species which were tested. Those of *R. odoratum* and *R. americanum* Mill. were nearly as weather resistant as those of *R. nigrum*. Those of *R. rotundifolium* became very brittle and tended to break into pieces. Those of *R. cynosbati* were so soft in texture that they matted together when wet, and soon decayed, thus causing the teliospores to germinate early. Those of *R. triste* Pallas acted much like those of *R. cynosbati*. Those of *R. glandulosum* tended to fall to pieces from weathering, and matted into a damp mass in which the teliospores soon became exhausted by germinating. This effect was retarded in our tests by shaking the leaves up after each rain (8).

The habitat of the *Ribes* host also has a direct influence upon the longevity of the teliospores upon its leaves. Some species, such as *R. glandulosum*, typically grow in wet situations, where the fallen leaves soon mat down and usually remain damp, so that the teliospores are soon germinated. Others, such as *R. cynosbati*, flourish in dry locations, where the fallen leaves, in spite of their soft texture and rather fragile character, resist decay for a long time. This may help to explain why damage to white pines from the latter species is usually high, while that from *R. glandulosum* is apt to be low. The fact that the leaves of *R. cynosbati* usually remain dry longer than those of *R. glandulosum* favors their blowing around and thus disseminating the disease.

DISCUSSION OF WEATHER CONDITIONS IN RELATION TO PINE INFECTIONS

York and Snell (12) found that infection of one- and three-year-old seedlings of *Pinus strobus* L. may occur within 12½ hours after inoculation with sporidia of *Cronartium ribicola*. They also found that sporidia can begin to germinate one hour after maturing. Allowing 5 hours, the minimum time found by them to be necessary for the formation of mature sporidia, a period of 18 hours of suitable weather would be sufficient for some infection of pines to take place (12). Many times it would take some hours longer for abundant infection to occur, as the writers got abundant crops of sporidia only after 12–20 hours (9). Work with the sporidia (9) shows that when the atmosphere contains more than 70 per cent relative humidity, they will survive an exposure in an air dried condition for as long as 26 hours. From August 1 to October 10, 1923, there were at Warrensburg, New York, seven periods, which were 36 or more hours long, during which the relative humidity of the air remained above 70 per cent. It appears, then, that infection of pines might have taken place during any or all of these apparently favorable periods.

Prolonged experience shows that the teliospores of *Cronartium ribicola* need moisture for their germination. Rain, dew, or heavy fog seems to be needed to cause them to germinate freely under natural conditions and to produce an abundant crop of sporidia. In fact, they are frequently found germinating and producing sporidia in nature immediately after a rain, especially if the rain is followed by cloudy weather. The sporidia are undoubtedly largely wind disseminated. It is known that the sporidia of many of the Uredinales are forcibly thrown off when they are mature (1), and it is assumed that those of this fungus also are thus set free. The slightest air current will carry them away. There probably is not an instant when slight convection currents are not in motion and capable of carrying these extremely light bodies to an indefinite distance. Falling precipitation is known to carry down minute particles such as dust, bacteria, and fungous spores which float in the air, the amount of such material in the air being at a minimum just after a rain or snow storm (2). Therefore there can be no effective dissemination of the sporidia while rain is falling. If a rain continues so long that most of the teliospores germinate and form sporidia, the latter, which are normally set free upon reaching maturity, are carried down by the falling drops of rain or mist. It appears, then, that natural infection of pines must take place during cloudy weather following a rain, fog, or dew, which is of such a length that the teliospores germinate freely and form a maximum crop of sporidia. The rain must not continue much longer or most of the sporidia will be washed down from the air as soon as formed, and thus rendered innocuous to the pines. It is not likely that sporidia, once washed to the ground, are ever again picked up in a viable condition by the wind. Sunny weather dries the air to such a point that the sporidia can not survive any length of time. The amount of air moisture is reduced quite promptly in full sunshine. The resulting dryness stops germination of teliospores and the rapidity with which sporidia are formed and set free.

While the knowledge about all of the factors concerned in the infection of pines by sporidia of *Cronartium ribicola* is admitted to be very incomplete, it seems that enough is known to justify an attempt to express their relation graphically. Figures 1 to 5 are intended to indicate certain conditions, part of which presumably result in infection of pines, and part of which presumably result in no infections. They are merely suggestive and represent but a few out of many combinations of conditions which might have been used. They are based upon data obtained in actual field work. The periods of time indicated undoubtedly will change with accompanying conditions, and in some instances they will be shortened. The present known minimum periods of time are used. The spaces from left to right indicate hours. The various bars are so designated as to be readily interpreted.

Figure 1 is intended to show conditions presumably favorable for rather heavy infection of pines. The upper bar represents the occurrence of rain, cloudy weather and sunshine during the indicated periods. Rain for 7 hours, ending quite abruptly, is followed by a period of 23 hours of cloudy weather and night; after 30 hours sunshine appears and continues. The solid black part of this bar represents rain, the stippled part cloudy weather or night, and the unshaded part sunny weather. The bar next to the top indicates the period of production of the sporidia by the germinating teliospores. This starts at the end of five hours, the known minimum (12) from which infection has been induced. In a single test by the writers (9), sporidia began to form in three hours, but this appears to be earlier than usual. The five hour period is based on numerous tests, and is therefore adopted here. The production of sporidia ends when the sun appears, after thirty hours. The middle bar shows the period of dissemination of the sporidia. The first part of it is dotted to indicate very limited dissemination while rain is falling. Promptly upon the termination of the rain, dissemination is in full swing, as it depends upon production which is shown to be heavy at this time. Dissemination ends with the stoppage of production, when the sunshine begins. The next to the last bar represents the germination of sporidia. This is known to start within one hour after they mature (9, 12). It also stops with the beginning of the sunshine. The last bar indicates the period of infection of white pines. The known minimum period for this is 11½ hours after germinating sporidia are placed upon the leaves of the pines (12). It is assumed that about one hour is needed for germination to attain a maximum rate. Therefore this bar starts 17½ hours after rain began (11½ after the first germination of sporidia) and continues until the sun shines. As far as external conditions are concerned, it appears that this set of conditions ought to result in rather heavy infection of neighboring white pines. But it must be stated that we know noth-

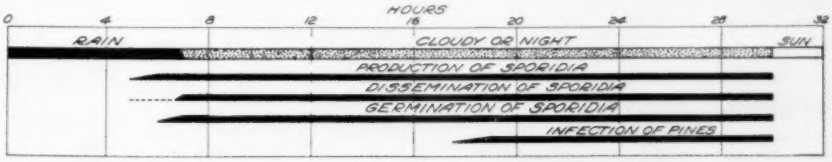

FIGURE 1. Bar diagram showing weather conditions presumably favorable for the heavy infection of *Pinus strobus* by the sporidia of *Cronartium ribicola*. The top bar represents the weather conditions. The solid black portion of it indicates rain; the stippled portion, cloudy weather or night; and the unshaded portion, sunshine. The second bar represents the period of production of sporidia. The third bar represents the period of dissemination of sporidia. The fourth bar represents the period of germination of sporidia. The fifth bar represents the period of infection of pines. This diagram presupposes a large crop of recently matured telial columns.

ing of the conditions within the pine leaves which favor or inhibit infection. A study of the infections of white pines which have occurred naturally in the forests shows plainly that heavy pine infections occur only once in several years, the intervening years being periods of mere scattering infections. It is quite evident that all periods of the type shown in figure 1 do not result in heavy infection of pines; otherwise there would be no coping with the disease before it destroyed our white pine stands. There is scarcely a year during which there is not one or more periods of weather similar to that sketched above. There is some unknown factor which has a decisive influence in the infection of white pines.

Figure 2 shows conditions which will presumably result in slight infection of pines. Conditions are the same as those shown in figure 1 except that the sun begins to shine earlier (soon after infection has started). It is quite evident that the total amount of infection would be small.

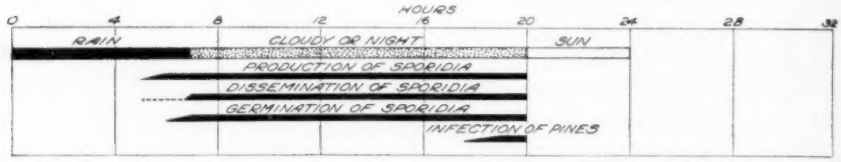

FIGURE 2. Bar diagram showing weather conditions which would presumably result in slight infection of *Pinus strobus* by the sporidia of *Cronartium ribicola*. The top bar represents the weather conditions. The second bar represents the period of production of sporidia. The third bar represents the period of dissemination of sporidia. The fourth bar represents the period of germination of sporidia. The fifth bar represents the period of infection of pines. This diagram presupposes a large crop of recently matured telial columns.

Figure 3 starts with the same conditions as figure 1 but the cloudy weather is cut short by the appearance of the sun at the end of fourteen hours, which is presumably before any infection could take place. The fifth bar is omitted to indicate this fact.

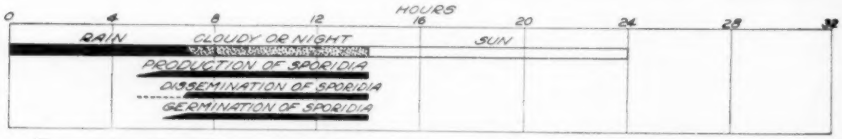

FIGURE 3. Bar diagram showing weather conditions which would presumably not result in the infection of *Pinus strobus* by the sporidia of *Cronartium ribicola*. The top bar represents the weather conditions. The second bar represents the period of production of sporidia. The third bar represents the period of dissemination of sporidia. The fourth bar represents the period of germination of sporidia. There is no fifth bar because no infection took place. This diagram presupposes a large crop of recently matured telial columns.

Figure 4 indicates a prolonged period of rain followed at once by sunshine. Production of sporidia reaches a maximum rate, but dissemination of the sporidia is almost entirely prevented by the falling rain which carries them down to the ground almost as soon as they are set free. A dotted line in place of a third bar indicates that a trace of dissemination may have taken place. Germination of the sporidia proceeds as long as they are moist, regardless of their location. Hence this bar is shown in full. Since the dissemination of the sporidia is reduced to a trace, the amount of infection which these few sporidia can cause is also reduced to a mere trace. The last bar consists of a dotted line to indicate this state of affairs.

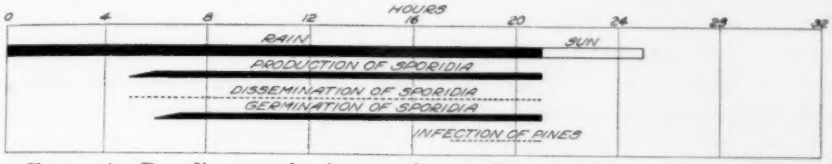

FIGURE 4. Bar diagram showing weather conditions which would presumably result in little or no infection of *Pinus strobus* by the sporidia of *Cronartium ribicola*. The top bar represents the weather conditions. The second bar represents the period of production of sporidia. The third bar is represented by a dotted line to indicate that the dissemination of sporidia is reduced to a mere trace. The fourth bar represents the germination of sporidia. The fifth bar is also represented by a dotted line to indicate that there was little or no infection. This diagram presupposes a large crop of recently matured telial columns.

Figure 5 indicates what happens when rain alternates with sunny weather, a thing which often occurs. Under these conditions sporidia may be formed and disseminated and begin to germinate, but the early appearance of the sun prevents their causing infection.

It should be stated that all five of these diagrams presuppose that there has recently been produced a large crop of mature telia which are ready to germinate under suitable conditions. As stated above, the time necessary for the telia to germinate increases with their age.

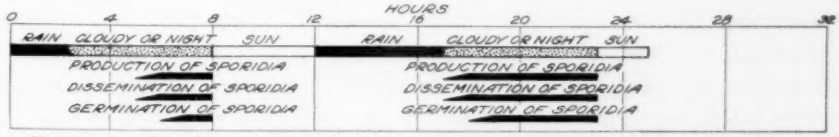

FIGURE 5. Bar diagram showing other weather conditions which presumably would not result in the infection of *Pinus strobus* by the sporidia of *Cronartium ribicola*. The top bar represents the weather conditions. The second bar represents the period of production of sporidia. The third bar represents the period of dissemination of sporidia. The fourth bar represents the period of germination of sporidia. There is no fifth bar because no infection took place. This diagram presupposes a large crop of recently matured telial columns.

It was intimated above that there are numerous questions in regard to the infection of pines by sporidia of *Cronartium ribicola* upon which we have little or no information. It may not be amiss to suggest some of these at this time. How long a time is required for all of the teliospores of a given generation to germinate? Are new telia formed during rain storms? Do immature telia mature during rain? How long a time is required for the formation of a mature telium? What period of time intervenes between the beginning and the crest of sporidial germination? Are sporidia which have already reached the needles of a pine washed off by rain? What is the minimum time for infection of pine needles after germinating sporidia are placed upon them? How long after the beginning of infection is the crest of infection? Why does not infection always occur when external conditions are apparently favorable to it? The number of such questions could be considerably increased, but these are sufficient to show some of the difficulties of the problem.

SUMMARY

Some of the factors influencing the period of production of the telia of *Cronatrium ribicola* are: weather conditions, time of season when the *Ribes* drop their leaves, and the varying ability of the species of *Ribes* to produce a second crop of leaves after the first has been dropped.

The germination of the teliospores is especially dependent upon moisture. Temperature *per se* does not seem to be so important; low temperatures merely inhibit or check the rate of germination. High temperatures have not been tested. Newly-matured teliospores germinate abundantly in about six hours at 75° F., while they require about twelve hours at 55–70° F. Increase in age increases the time needed for germination.

Longevity in this paper means the length of time during which teliospores remained ungerminated and still viable. Some of the factors influencing longevity of teliospores are: the habitat of the *Ribes* hosts, and the structure of the *Ribes* leaves. Both are closely associated with the access of moisture to the teliospores.

The factors which are necessary for the infection of white pines by *Cronartium ribicola* are many, and some of them are not known. It is known that there must be a period of sufficient moisture to germinate the teliospores, and that this must be followed by a period of high humidity during which the infection can take place. An attempt has been made to illustrate some of these conditions graphically.

Questions which need investigation are suggested.

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

LITERATURE CITED

(1) BULLER, A. H. R. Researches on Fungi, 3, 611 pp. Longmans, Green and Co., London. 1924.

(2) ———— and CHARLES W. LOWE. Upon the number of microorganisms in the air of Winnipeg. Proc. and Trans. Roy. Soc. Canada, III,4[1]: 41–58. 1911.

(3) COLLEY, R. H. Parasitism, morphology and cytology of *Cronartium ribicola*. Jour. Agr. Res. **15**: 619–660. 1918.

(4) DORAN, W. L. The minimum, optimum and maximum temperature of spore germination in some Uredinales. Phytopath. **9**: 391–402. 1919.

(5) REED, H. S., and C. H. CRABILL. The cedar rust disease of apples caused by *Gymnosporangium juniperi-virginianae* Schw. Virginia Agr. Exp. Sta. Tech. Bul. 9: 1–106. 1915.

(6) SPAULDING, PERLEY. Investigations of the white-pine blister rust. U. S. Dept. Agr. Bul. 957: 1–100. 1922.

(7) ————. Viability of telia of *Cronartium ribicola* in early winter. Phytopath. **12**: 221–224. 1922.

(8) ———— and ANNIE RATHBUN-GRAVATT. Longevity of teliospores and accompanying uredospores of *Cronartium ribicola* Fischer in 1923. Jour. Agr. Res. In press.

(9) ———— ————. Influence of physical factors on the viability of sporidia of *Cronartium ribicola* Fischer. In manuscript.

(10) TAYLOR, MINNIE W. Potential sporidia production per unit in *Cronartium ribicola*. Phytopath. **12**: 298–300. 1922.

(11) TULASNE, L. R. Second mémoire sur les Urédinées et les Ustilaginées. Ann. Sci. Nat. Bot. IV, **2**: 77–196. 1854.

(12) YORK, H. H., and W. H. SNELL. Experiments in the infection of *Pinus strobus* with *Cronartium ribicola*. Phytopath. **12**: 148–150. 1922.

INOCULATION OF PINUS STROBUS TREES WITH SPORIDIA OF CRONARTIUM RIBICOLA

WALTER H. SNELL AND ANNIE RATHBUN-GRAVATT[1]

WITH TWO FIGURES IN THE TEXT

INTRODUCTION

From 1918 to 1922 the Office of Investigations in Forest Pathology carried out at North Conway, New Hampshire, a rather comprehensive program of field investigations of white pine blister rust. Part of the work was conducted by the present writers, under either the immediate direction or general supervision of Drs. Perley Spaulding and H. H. York. One phase of the work was the inoculation of *Pinus strobus* L. with sporidia of the white pine blister rust fungus, *Cronartium ribicola* Fischer. The present paper is a preliminary report of the successful inoculation of large trees in August and September, 1922.

Very little work has been done upon the conditions necessary for the infection of pines by sporidia, largely because of the difficulty of successfully inoculating them. The number of infections resulting from inoculations of white pines with *Cronartium ribicola* reported in literature is very small, and most of those reported have been on seedling pines. In 1912 Spaulding (6, 7) reported positive results from stem inoculations of young pines in the greenhouse. Clinton (1, 2, 3) was apparently the first American to secure infections through needles of a white pine as a result of artificial inoculation. Most of his successful infections occurred upon seedling pines in a greenhouse. Inoculations out-of-doors on trees 6 to 20 years old failed (2). In 1903, in Europe, Klebahn (5) successfully inoculated two young white pines under a bell jar. Tubeuf (8) also secured infection of young white pines. He found that he could infect 2-year old plants of *Pinus strobus* more readily than older ones.

1921 York and Snell (9) successfully inoculated 1918 and 1921 seedling pines out of doors in "iceless refrigerators" such as those described by Hunt (4). In less than three months after inoculation, some of the seedlings gave positive evidence of infection. Ultimately about two-thirds of them showed evidence of rust. In 1922 this experiment was successfully repeated by the writers.

Inoculations on large white pines at North Conway, however, had led to rather disappointing results. Some of the inoculations caused infection, but the percentage was too insignificant to give satisfactory data in the

[1] Glenn G. Hahn assisted in part of this work in the summer of 1922.

various studies. York's original method of inoculating large white pines was to germinate telial columns by floating them on the surface of water for about six hours, and then to enclose the telial columns and sporidia in leaf bundles of the pines. In 1922, however, the use of methods similar to those used in inoculating seedling pines (9) gave results which are more satisfactory.

METHODS AND CONDITIONS OF INOCULATION

The inoculating material used was collected from two patches of *Ribes nigrum* L. bushes, one in North Conway and the other north of Crawford Notch at Twin Mountain, New Hampshire, from some *R. odoratum* Wendl. bushes near Glen Station, New Hampshire, and from some *R. cynosbati* (L.) Mill. bushes at Jackson, New Hampshire. The method of inoculation used in 1922 simulated natural conditions as far as posssible. The greatest care was taken in selecting the inoculating material. The patches of Ribes were watched constantly for new generations of telia and, at the proper times, the leaves were picked and placed in an icebox, where they were kept for at least twelve hours before use. Usually at noon, or in special experiments, earlier or later, the infected leaves were cut in halves or quarters, according to size, and the pieces were placed in Petri dish moist chambers, such as previously described (9), for a period of six hours, to induce germination of the telia. At the end of this period, which was usually between 6 P.M. and nightfall, the dishes were carried to the previously selected field locations.

The places chosen for the inoculation of pines were in a region from which the *Ribes* had been eradicated in 1916. Thus the danger of natural infection of the experimental pines and that of the dissemination of the disease from the experimental plots to other pines were practically obviated. Within one experimental plot one white pine with a stem canker was found. This infection apparently occurred before the date of *Ribes* eradication.

The pines selected for inoculation were of two types: (1) small trees five to fifteen years of age, which could be entirely covered by moist chambers; and (2) the lower branches up to a point ten feet from the ground, of trees fifteen to over thirty years of age, which could be bent down so that the ends could be fastened under moist chambers. In the former case every twig of the tree, and in the latter every twig on the distal two or three feet of the branches, was inoculated.

Prior to inoculation, each branch was sprayed by means of a watering can (Fig. 1). Subsequently each twig was sprayed lightly with water by means of an atomizer. The portions of *Ribes* leaves with the germinated telia were then applied to the clusters of needles which were pressed together

FIG. 1. The moist chambers used in inoculating large *Pinus strobus* trees with *Cronartium ribicola*. Note the size of trees used. Photograph by H. W. Snell.

loosely and fastened about half way round the clusters by small "invisible" wire hairpins (Fig. 2). This latter expedient proved of great convenience, because it not only provided a means for holding the leaf inoculum properly and securely in place, but also allowed ease and great rapidity in performing the work.

After inoculation the branches were again lightly sprayed and fastened in moist chambers. The moist chambers used were modifications of the "iceless refrigerator" described by Hunt (4). In all cases the moist chambers consisted of the same three parts—a reservoir, a support, and a cloth covering—which Hunt used. The reservoirs were dish pans or tubs of water. The covering consisted of two curtains—an inner one of thick, unbleached cotton cloth and an outer one of fine cheese cloth. York had found this combination most effective for keeping the curtains uniformly wet without wasting the water. Each curtain was tubular in form and was drawn together at the top with a puckering string. Various types of frames and forms similar to that described by Hunt have been used for supporting the reservoirs (Fig. 1), but these were found cumbersome to move about the woods. For this reason few of these frames were used in 1922. For most of the moist chambers the supports consisted of three stakes, cut on

the spot in the woods, and driven into the ground until their tops were level. The reservoir was set upon the tops of these sticks, the curtains were hung in place, and sphagnum moss was placed upon the ground inside. Then the whole was wet and the inoculated branch enclosed within it. The use of stakes instead of frames made it much easier to use "iceless refrigerators" when making inoculations in the woods.

The inoculated branches remained in the moist chambers at least twenty-four hours, and sometimes thirty-six. Most of the experiments were begun at nightfall in order to take advantage of the naturally high humidity prevailing at night, because this prevented the evaporation of much water from the moist chambers. This arrangement made it possible not only to secure natural high humidity during the first stages of penetration of the needles by the sporidial germ tubes but also to obtain a second period of high night humidity, with only one intervening day of entirely artificially maintained humidity. At the end of twenty-four or thirty-six hours the

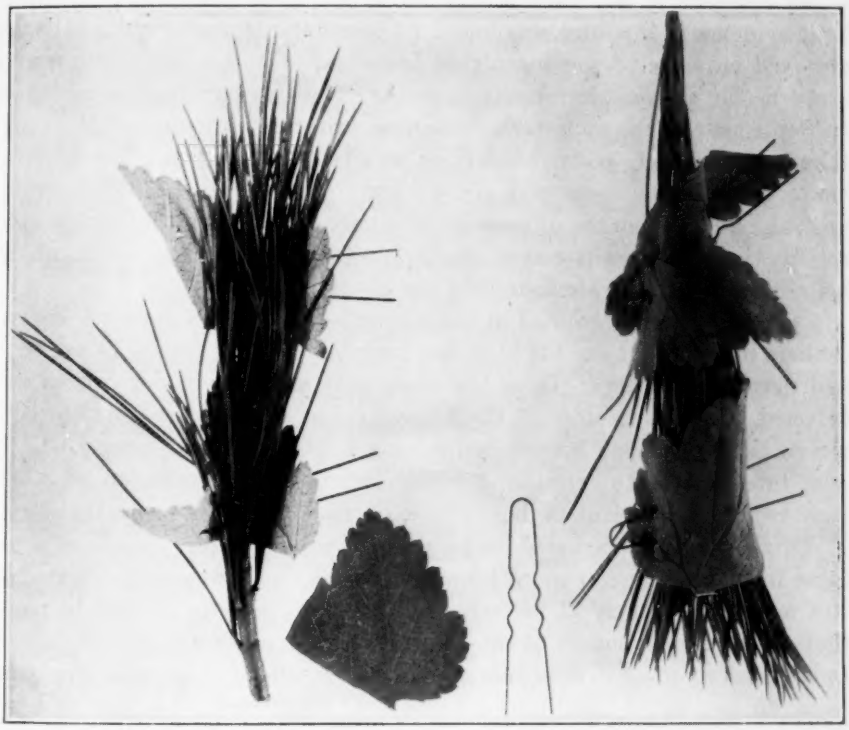

FIG. 2. Method of inoculating white pine twigs with *Cronartium ribicola*. The host from which the inoculum was secured was in this case *Ribes vulgare*. Note that the leaves were cut. The twig at right shows upper view; that at left shows lower one.

branches were removed from the moist chambers, and the inoculum was removed and buried.

The moist-chamber method of inoculation described above was used in inoculating 144 branches on 51 different white pines, ranging in age from 5 to more than 30 years. Most of them were over 15 years old.

Fifty-three additional branches on 9 of the same large trees were inoculated during the same period in the morning on different rainy days which promised to maintain a high atmospheric humidity. The method of inoculation was identical with that described above except that no moist chamber was used.

In addition, several small *Pinus resinosa* Ait. trees were inoculated during the same period to see whether or not the characteristic spots which indicate infection with *Cronartium ribicola* would form on their needles (2).

RESULTS OF THE INOCULATIONS

In June, 1923, the inoculated trees were inspected, and comparatively little evidence of infection was found. Characteristic needle spots (2) were observed on some of the inoculated branches. On one small tree nearly every needle showed characteristic spots. No twigs had become cankered. In September of the same year the senior writer again inspected them and found one definitely positive infection on a twig and several other doubtful ones. Some needle spots were also evident. In September, 1924, however, he found quite a number of positive infections on twigs and numerous indications that more positive ones might appear in 1925. The results of the inspection made in September 1924 are given in table 1.

Of the 51 trees inoculated in moist chambers, 18, or 35 per cent, showed cankers in 1924. Of the 144 branches inoculated, 20, or nearly 14 per cent, had developed cankers. On a few trees, only one twig of one branch was infected. However, most of the branches had cankers on from three to eleven twigs, and one branch had a canker on every twig inoculated. It is of interest to note here that the inoculations of trees over ten years old were twice as successful as those of trees between five and ten years of age.

Of the 9 trees inoculated on rainy days without moist chambers, 6 became infected in one or more branches. Of the 53 branches inoculated in this way, 11, or nearly 21 per cent, had become diseased. It is to be noted that a greater percentage of the inoculations not moist chambered than of those moist chambered were successful. The results of one season's inoculations do not prove that this difference is significant. On one tree six branches were infected, and on most of the infected branches there was more than one cankered twig.

No infections have yet been observed on needles or branches of *Pinus resinosa* inoculated with *Cronartium ribicola*.

TABLE 1.—*Results of inoculating native large white pines with the sporidia of Cronartium ribicola at North Conway, N. H., in 1922*

Age of inoculated trees (Yrs.)	Number of trees inoculated	Number of trees infected	Per cent of trees infected	Number of branches inoculated	Number of branches infected	Per cent of branches infected
			INOCULATED IN MOIST CHAMBERS			
5–10	7	2	29	50	4	8
10–over 30	44	16	36	94	16	17
Total	51	18	35	144	20	14
			INOCULATED WITHOUT MOIST CHAMBERS			
20–30	9[a]	6[a]	67	53	11	21
Total	51[a]	18[a]	35	197	31	16

[a] The inoculations which were not moist chambered were on the same trees with those which were moist chambered.

The data in regard to the source of the inoculum are not of great value because of the small number of tests with that from three of the sources. They are presented here for what they may be worth. In 16 tests with sporidia from *Ribes nigrum* collected at Twin Mountain, 18 per cent of the inoculations were successful. In 3 tests of those from *R. nigrum* collected at North Conway, 16 per cent were successful. In 3 tests with those from *R. odoratum*, 11 per cent were successful; and, in 2 tests with those from *R. cynosbati*, none of the inoculations were successful.

Inoculations were made upon both 1922 and 1921 needles, but the data upon their relative susceptibility are not yet complete. The evidence at present available is that the inoculations were as successful upon the two-year-old needles as upon the one-year-old needles.

The above results are presented because they represent the first really successful attempt to inoculate large white pines with the sporidia of *Cronartium ribicola*. It is realized that the percentage of successful inoculations is very small, but these results are much better than any attained before on older pines. They show that there is still a considerable gap in our knowledge either of the conditions of infection of *Pinus strobus* by *Cronartium ribicola*, of the periods of susceptibility of the pine needles, or of the viability of the teliospores or sporidia.

Later inspection may show considerably more infection than that found in 1924, as the period of incubation for *Cronartium ribicola* in the pine is sometimes several years.

SUMMARY

Account is given of the method used in inoculating large *Pinus strobus* trees with *Cronartium ribicola* at North Conway, N. H., in 1922.

Eighteen of the 51 trees inoculated in moist chambers had become diseased, and 20 of the 144 branches inoculated had become cankered in 1924.

Six of the nine trees inoculated under natural conditions, without subsequent moist chambering, had become diseased; and eleven of the 53 branches thus inoculated had become cankered in 1924.

The possibility of more infections appearing in 1925 or later is discussed.

No infection had occurred upon small *Pinus resinosa* trees in 1924.

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

LITERATURE CITED

1. CLINTON, G. P. Artificial infection of *Ribes* species and white pine with *Cronartium ribicola*. Amer. Plant. Pest Comm. Bul. 2: 14–15. 1918.
2. CLINTON, G. P. and F. A. MCCORMICK. Infection experiments of *Pinus strobus* with *Cronartium ribicola*. Conn. Agr. Exp. Sta. Bul. 214: 428–459. 1919.
3. CLINTON, G. P. and F. A. MCCORMICK. Artificial infection of pines with *Cronartium ribicola*. Amer. Plant Pest Comm. Bul. 4: 12. 1919.
4. HUNT, N. R. The "iceless refrigerator" as an inoculation chamber. Phytopath. 9: 211–212. 1919.
5. KLEBAHN, H. Kulturversuche mit Rostpilzen. Infektion von *Pinus strobus* L. mittels *Cronartium ribicola* Dietr. und Rückschlage zur Jugendform bei Kiefern. Ztschr. für Pflanzenkr. 15: 86–92. 1905.
6. SPAULDING, P. Notes upon *Cronartium ribicola*. Science, N. S. 35: 146–147. 1912.
7. SPAULDING, P. Notes upon *Cronartium ribicola*. (Abst.) Phytopath. 2: 47. 1912.
8. TUBEUF, CARL VON. Über das Verhältnis der Kiefern-Peridermien zu Cronartium. II. Studien über die Infektion der Weymouthskiefer. Naturw. Ztschr. Forst. u. Landw. Jahrg. 15. Heft 7/9. p. 268–307. 6 Abt. 1917.
9. YORK, H. H. and W. H. SNELL. Experiments in the infection of *Pinus strobus* with *Cronartium ribicola*. Phytopath. 12: 148–150. 1922.

A PARTIAL EXPLANATION OF THE RELATIVE SUSCEPTIBILITY OF THE WHITE PINES TO THE WHITE PINE BLISTER RUST (CRONARTIUM RIBICOLA, FISCHER)

PERLEY SPAULDING

THE RELATIVE SUSCEPTIBILITY OF THE WHITE PINES TO THE BLISTER RUST

The writer has had an opportunity to see the white pine blister rust, *Cronartium ribicola* Fisher, in all of the principal outbreak areas of North America and in numerous localities of western and northwestern Europe. These extensive observations have led naturally to the making of comparisons of the behavior of this disease upon its different hosts and in different localities upon the same host. *Pinus cembra* L., the presumed original pine host of the blister rust, has two varieties which vary in susceptibility. The variety native in the Alps appears to be quite resistant; the variety native in Russia and Siberia appears to be quite susceptible. There is reason for believing that most of the *P. cembra* growing in western Europe is of the alpine variety; at any rate, it quite rarely becomes infected by blister rust. *P. cembra* is rather limited in distribution in Europe west of Russia, both naturally and as an ornamental. On the other hand, *P. strobus* L. is widely distributed over nearly all of this region, although it is thinly scattered as compared with a native species of similar, wide distribution, such as *P. sylvestris* L. General experience shows that *Pinus strobus* is much more commonly attacked by this disease in Europe than is any other species of pine. Indeed, it can be said that the distribution of the disease is practically identical with that of this tree. Because of their relatively small numbers and consequent limited distribution, *P. flexilis* James and *P. monticola* Douglas are not important hosts of the blister rust in Europe; the frequency with which the disease occurs upon the rather small numbers seen indicates clearly that they are both more susceptible than *P. strobus*.

American experience in British Columbia, where *Pinus monticola* is generally infected in its native habitat, shows plainly that this species is more susceptible than *P. strobus* growing in the same locality and out of its native range. This fully corroborates European experience, where both species are out of their native habitats. Very little *P. monticola* is known in the native range of *P. strobus*, but the few that have been seen are attacked by the blister rust. Comparison of the disease attacks upon these two species, when each is growing in its native habitat, also shows that *P. monticola* is more susceptible than is *P. strobus*. In this particular case, changed climatic conditions, within which both grow reasonably well, do not seem to influence their relative susceptibility.

As above stated, *Pinus flexilis* is more susceptible than *P. strobus* in Europe. Experience here in America is limited to a small comparative test (4) made by the writer. This indicated clearly that *P. flexilis* is more susceptible than is *P. strobus*. Under conditions foreign for both species, and under the conditions of the habitat of *P. strobus*, their relative susceptibility remains constant.

In another paper (7) the writer has ventured to make an estimate of the relative susceptibility of the white and pinon pines to the white pine blister rust. The disease is epidemic in North America only within the ranges of *Pinus strobus* and *P. monticola*. Hence American experience is extensive with these two species, but with no others. The disease is generally prevalent in the countries of western and northwestern Europe. It can be said then that all of the pines which are cultivated to any extent there have been subjected to infection by the disease. With this understanding of the situation one may comprehend the following grading of the pines.

TABLE 1.—*The estimated relative susceptibility of the white and pinon pines to the white pine blister rust.*

O. Immune, but too few tested for reliable estimate.
- *Pinus armandi* Franchet.
- " *bungeana* Zuccarini.
- " *cembroides* Zuccarini.
- " *monophylla* Torrey.
- " *parryana* Engelmann.
- " *edulis* Engelmann.

X. Resistant, but too few individuals, except of the first three, tested for reliable estimate.
- *Pinus cembra* var. *helvetica*
- " *excelsa* Wallich.
- " *peuce* Grisebach.[1]
- " *aristata* Engelmann.
- " *balfouriana* Balfour.
- " *koraiensis* Siebold and Zuccarini.
- " *parviflora* Siebold and Zuccarini.

XX. Susceptible, but the last three species tested in limited numbers.
- *Pinus cembra* var. *sibirica*[2]
- " *strobus*
- " *ayacahuite* Ehrenberg.
- " *lambertiana* Douglas.
- " *strobiformis* Engelmann.

[1] This estimate is based upon reports of resistance in Germany.

[2] This estimate is based in part upon reports of susceptibility in Russian literature.

XXX. Very susceptible, but first species tested only in limited numbers.

Pinus albicaulis Engelmann.
" *flexilis*
" *monticola*

As stated above, there are but a few species of the white and pinon pines which have been exposed to the attacks of the blister rust in large enough numbers to enable one to rank them in susceptibility with confidence. The species which have been tested in numbers are: *P. monticola*, *P. flexilis*, *P. strobus*, *P. lambertiana*, *P. excelsa*, *P. peuce*, *P. cembra* var. *helvetica*, and *P. cembra* var. *sibirica*. The ranking of the rest is purely tentative and liable to change as a result of future tests.

THE RELATIVE PERSISTENCE OF THE LEAVES AND DISTRIBUTION OF STOMATA ON THE LEAVES OF THE WHITE AND PINON PINES

The different species of white and pinon pines vary greatly in the length of time that they regularly retain their leaves. Data concerning this is taken from Sargent (5), Sudworth (8, 9), and Elwes and Henry (3).

TABLE 2.—*Persistence of the leaves of the white and pinon pines, and the distribution of the stomata upon the leaves.*

Species and susceptibility	No. of years the leaves persist	Stomata on the leaves
Pinus lambertiana XX	2–3	On inner and outer sides
" *peuce* X	2–3	" " side only
" *strobus* XX	2–3	" " " "
" *ayacahuite* XX	3	" " and outer sides
" *excelsa* X	3	" " " " "
" *parviflora* X	3	" " side only
" *bungeana* O	3–4	" " and outer sides
" *cembroides* O	3–4	" " " " "
" *monticola* XXX	3–4	" " " " "
" *parryana* O	3–4	" " " " "
" *cembra* X–XX	3–5	" " side only
" *edulis* O	3–5	" " and outer sides
" *koraiensis* X	3–5	" " " " "
" *strobiformis* XX	4	" " " " "
" *monophylla* O	4–5	20 lines of stomata
" *albicaulis* XXX	4–8	On inner and outer sides
" *flexilis* XXX	5–6	" " " " "
" *balfouriana* X	10–12	" " side only
" *aristata* X	12–14	" " " " "
" *armandi* O	(?)	" " " " "

It should be stated that, with most of the species having stomata on the outer surface of the leaves, the tendency is for the stomata on that surface to be rather few and to be located near the tip of the leaf.

CORRELATION OF SUSCEPTIBILITY WITH LEAF PERSISTENCE AND DISTRIBUTION OF THE STOMATA ON THE LEAVES OF THE WHITE AND PINON PINES

The writer's ranking of the pines in relative susceptibility was done in 1923, while preparing his notes upon the white pine blister rust in Europe for publication, and before any attention was given to the leaf persistence of the different species. For this reason it is believed that an unbiased opinion has been obtained, since the leaf persistence is based entirely upon published data of other investigators. In attempting to correlate susceptibility with leaf persistence, one is forced to eliminate some species because of too limited knowledge of their susceptibility, or include all with the distinct understanding that their grading is merely tentative and liable to change. The latter course seems better. The reliability of the estimates is indicated in table 1, so that there need be no misunderstanding concerning it. The available data may be presented in tabular form to the best advantage.

TABLE 3.—*The relative susceptibility, leaf persistence and distribution of the stomata upon the surfaces of the leaves of the white and pinon pines*

Pinus species	Susceptibility	Persistence of leaves in years	Distribution of the stomata on the leaves
albicaulis	Very susceptible	4–8	On inner and outer sides
flexilis	" "	5–6	" " " " "
monticola	" "	3–4	" " " " "
ayacahuite	Susceptible	3	" " " " "
cembra var. *sibirica*	"	3–5	" " side only
lambertiana	"	2–3	" " and outer sides
strobiformis	"	4	" " " " "
strobus	"	2–3	" " sides only
aristata	Resistant	12–14	" " " " "
balfouriana	"	10–12	" " " " "
cembra var. *helvetica*	"	3–5	" " " " "
excelsa	"	3	" " and outer sides
koriaensis	"	3–5	" " " " "
parviflora	"	3	" " sides only
peuce	"	2–3	" " " " "
armandi	Immune	?	" " " " "
bungeana	"	3–4	" " and outer sides
cembroides	"	3–4	" " " " "
edulis	"	3–5	" " " " "
monophylla	"	4–5	20 lines of stomata
parryana	"	3–4	On inner and outer sides

It has been shown that most of the infection of white pines by the white pine blister rust starts in the leaves, and that entry to the leaf is through

the stomata (1). It has also been determined that the fungus requires several months to reach the bark of the twig after infection is established within the leaf. Tests (1, 6, 10) show that with *Pinus strobus* the second year leaves may take infection about as readily as the first year ones. One may say that a considerable percentage of all of the infections take through the older leaves on both *P. strobus* and *P. monticola*. With *P. strobus*, there is a chance that the older infected leaves may drop before the fungus reaches the bark of the twig. This is believed to happen in many instances. Since *P. monticola* retains its leaves a year longer than *P. strobus* does, a much larger number of the infections upon the older leaves will succeed in reaching the twig. Considering only the leaf casting, it is quite certain that those species of pines which retain their leaves for longer periods will prove to be more susceptible. Turning to table 3, what are the facts? In the first group of three "very susceptible" species, the average leaf persistence is decidedly longer than is that of the second group of five "susceptible" species, the ratio being about 5 to 3 years. This difference in years of persistence is believed to be significant. It can not be said that the two last groups show any relation between susceptibility and leaf persistence. Evidently some other factor is exerting a greater influence.

The writer would call attention especially to the characters of *P. strobus* and *P. monticola*, because of the great similarity of the two species. They are very similar in the relative size and shape of the crown, in the size, number, and distribution of the branches and twigs, and in the whorled arrangement of the branches upon the trunk. The latter, however, gives an impression of greater density and amount of foliage. This seems to be due to the twigs being clothed with at least one year's more leaves. Both of these species have been subjected to infection in their native habitats, so that their relative susceptibility is well established.

An examination of the possible influence of the stomata upon susceptibility results in the finding of the following facts. There is no data upon the number of stomata upon the leaves of the different species of pines; except statements that some of the species have a given number of rows of stomata on the inner surfaces of the leaves. The number in a row may, and probably does, vary much. There are certain species which have stomata only upon the inner surfaces of the leaves, while there are some which also have them upon the outer surface. The stomata upon the outer surface of the leaves are usually located toward the tip of the leaf. Since there is no definite indication of the actual number of stomata for the different species, it seems reasonable to assume that those species which have stomata upon the outer surface of the leaves also have larger numbers of stomata. It is apparent that a leaf which has stomata upon all surfaces is more apt to receive sporidia in close enough proximity to one so that infection will suc-

ceed, than is a leaf which has one-third of its surface without such openings for infection. This difference appears to be one which may be significant and is the basis of the present correlation. Turning to table 3, we find that all of the "very susceptible" species have stomata upon all of the leaf surfaces. The "susceptible" group of five species has three species with stomata upon all surfaces of the leaves, and two with them upon the inner surfaces only. The "resistant" group has two out of seven species with stomata upon all surfaces of the leaves. The "immune" group includes the pinon pines, which are not known to become infected by this fungus. If these be excluded, there are left two species, one of which has stomata upon all surfaces of the leaves, while the other has them upon the inner surfaces only. In the first three groups of table 3 there appears to be a correlation between the distribution of the stomata on the leaves and susceptibility of the species. This is more apparent when one remembers that the rated susceptibility of more than half of the species in the "resistant" and "susceptible" groups is liable to be raised by future tests.

THICKNESS OF INNER BARK A POSSIBLE FACTOR IN SEVERITY OF ATTACKS OF THE BLISTER RUST

Pinus strobus, in exceptionally severe attacks of the blister rust, may have many twigs killed by the fungus. Trees killed by it die from the girdling of the stem, however, not because all of the twigs are killed. *Pinus monticola* often dies from the effect of having all of the twigs killed. There appears to be a real difference in intensity of attack in the small twigs. On branches and stems there is a similar difference; on *P. strobus* the pycnia are usually separate and distinct from one another; on *P. monticola* they coalesce into continuous blotches or sheets. The amount of liquid exuded is decidedly greater with the latter also. There is thus good evidence that the fungus vegetates in the bark of *P. monticola* as it never does in the bark of *P. strobus*. There is a decided difference in the thickness of the smooth bark of the two species, that of *P. monticola* being thicker. The fungus vegetates largely in the inner bark tissues (2). Bark which has large amounts of such tissues would appear to favor such a fungus. The blister rust fungus certainly flourishes in trees which are especially vigorous in growth (1). The writer believes that the greater abundance of phloem in the bark of *P. monticola* directly favors the growth of the fungus.

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

LITERATURE CITED

1. CLINTON, G. P., and F. A. MCCORMICK. Infection experiments of *Pinus strobus* with *Cronartium ribicola*. Conn. Agric. Exp. Sta. Bull. 214: 428–459, illus. 1919.
2. COLLEY, R. H. Parasitism, morphology, and cytology of *Cronartium ribicola*. Jour. Agric. Res. **15**: 619–660, illus. 1918.
3. ELWES, H. J., and A. HENRY. The trees of Great Britain and Ireland. **5**: 1011–1060. Edinburgh. 1910.
4. PENNINGTON, L. H., W. H. SNELL, H. H. YORK, and P. SPAULDING. Investigations of *Cronartium ribicola* in 1920. Phytopath. **11**: 170–172. 1921.
5. SARGENT, C. S. Manual of the trees of North America. Ed. 2, 910 p., illus. Boston and New York. 1922.
6. SNELL, W. H., and A. RATHBUN-GRAVATT. Inoculation of large white pines with *Cronartium ribicola*. In press.
7. SPAULDING, P. Notes upon the white pine blister rust in Europe and upon conditions affecting its status. U. S. Dept. Agric. Bull. In press.
8. SUDWORTH, G. B. Forest trees of the Pacific Slope. U. S. Dept. Agric. Forest Serv. 441 p., illus. 1908.
9. ———. The pine trees of the Rocky Mountian region. U. S. Dept. Agric. Bull. 460. 47 p., illus. 1917.
10. YORK, H. H., and W. H. SNELL. Experiments in the infection of *Pinus strobus* with *Cronartium ribicola*. Phytopath. **12**: 148–150. 1922.

THE LOOSE SMUT OF RYE (USTILAGO TRITICI)

HARRY B. HUMPHREY and VICTOR F. TAPKE

WITH THREE FIGURES IN THE TEXT

INTRODUCTION

Rye in North America is subject to several disease-producing fungi, three of which are smuts. Of these, stem smut, *Urocystis occulta* (Wallr.) Rab., is of most frequent occurrence and greatest economic importance in the United States. The other smuts are loose smut, *Ustilago tritici* (Pers.) Jens., and bunt, *Tilletia tritici* (Bjerk.) Wint., the latter of which, according to Gaines and Stevenson (4), was observed by them at Pullman, Wash., on rye and on some wheat-rye hybrids. *Tilletia secalis* Kuehn may be synonymous with *T. tritici* though we are without the necessary cultural evidence to prove their identity. It is the opinion of Gaines and Stevenson (4) that they are one and the same species.

Although Kaspar Bauhin (1), in listing what he conceived to be species of *Ustilago,* included *U. secalena,* he does not describe it. We therefore are without any information as to which smut or other fungus he refers. In 1849, Rabenhorst (6) described as *Uredo secales* an odorless smut which, according to his description, is not an *Ustilago.* The *Ustilago secalis* Rabh. described by Fischer von Waldheim (2) apparently is synonymous with Rabenhorst's *Uredo secales.* It therefore seems quite probable that the occurrence of loose smut in rye was first recorded in 1914 (5) following its discovery in a field of spring rye on the Dickinson (N. Dak.) Substation in July, 1913. Vavilov (7) records his observations of this smut on rye in Persia, in 1916, and refers it to *Ustilago tritici* (Pers.) Jens. The records of the Office of Pathological Collections and Plant Disease Survey show a wide distribution of loose smut on rye in the United States. Since its discovery in North Dakota, it has been reported from the following states: Illinois, Indiana, Kentucky, Minnesota, Missouri, New York, Oklahoma, Virginia, West Virginia, and Tennessee. The frequency of its occurrence, however, has not been such as to give the disease more than a scientific interest. However, there always is the possibility of its becoming of economic importance through the introduction of more highly susceptible varieties of rye or through the development of virulent physiologic forms of the organism.

THE DISEASE

Symptoms.—Previous to heading there generally is no evidence by which a rye plant infected by loose smut may be recognized. Occasionally, however, streaks of smut may develop in the upper leaf before the head emerges,

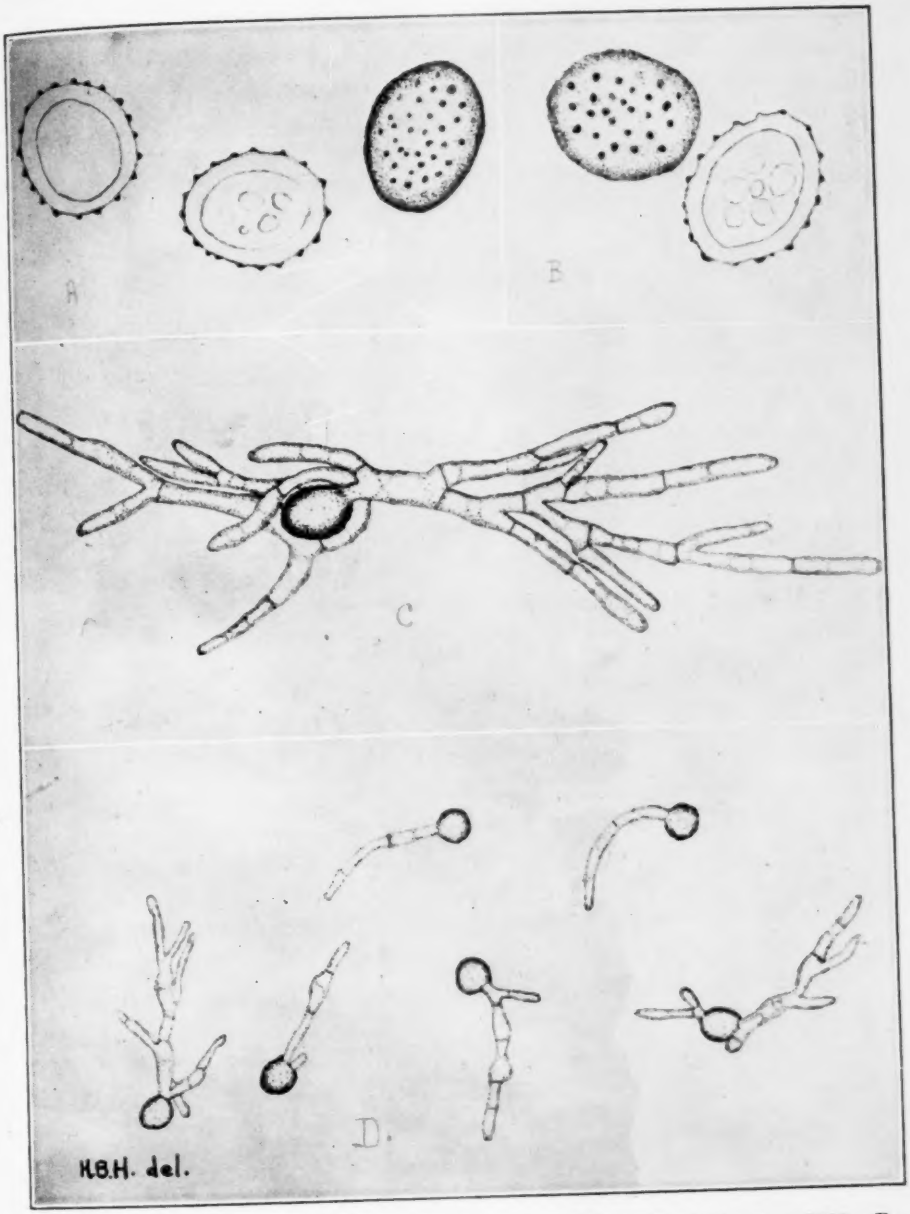

FIG. 1. A. Spores of *Ustilago tritici* from a smutted head of wheat. ×2400. B. Spores of *U. tritici* from a smutted head of rye. ×2400. C. An individual plant of *U. tritici* from a single spore taken from a smutted rye head. ×1000. D. Sporelings of *U. tritici* from a culture made from a transfer of spores from a smutted head of rye. ×500.

especially when the plants are grown in the greenhouse. Except as noted above, no parts of the plant other than the spikelets are affected. When the diseased head has emerged from the boot, the spikelets are seen to be almost completely destroyed and replaced by an odorless, powdery dark-brown mass of smut spores. In cases of partial smutting of the head, as noted below, some of the spikelets at the juncture of healthy and diseased tissues may be only partly destroyed. The effects of *Ustilago tritici* on heads of rye, therefore, are similar to those on heads of wheat, except that in rye partial smutting of the head seems to be the rule (Fig. 2), whereas in wheat (Fig. 3) it is the exception. In rye, as in wheat, partial smutting of the head always proceeds from the base upward, and in such cases all stages from complete to partial destruction of the floral parts will be found progressively from the base to the tip of the head (Fig. 2). Although the lower spikelets on a head of rye may be partially or wholly destroyed, the behavior of the flowers in the upper spikelets and the production and maturation of their seed proceed apparently in the normal manner.

INVESTIGATIONS

Methods.—A careful study of the behavior of the rye-smut fungus in artificial culture and a comparison of its morphologic characters with those of authentic *Ustilago tritici* led the writers to suspect the identity of the two smuts (Fig. 1). The spore characters of the two smuts were optically identical. An extensive series of spore measurements of the rye smut were made and compared with those of spores obtained from a smutted head of wheat. In both cases, when observed under high magnification, the spores were a pale olive-green color, somewhat lighter on one side, slightly oval, measuring from 5 to 9 μ in the greater diameter, and minutely but sparsely echinulate. Germination of the rye-smut spore, as in the case of the wheat-smut, proceeds with the development of a germ tube, often curved, which in water or nutrient solutions may become 5–7 septate and produce several branches. In no instance was there observed the development of any sporidia in cultures of either smut.

But, in order to establish beyond doubt the fact of their identity, some cross-inoculation experiments in the greenhouse and field were made in 1922 and repeated in 1923. These experiments involved the transfer of loose-smut spores from smutted heads of wheat to the ovaries of normal rye plants. Reciprocal cross inoculations also were made. Following is the method of inoculation employed. Heads were selected on plants of Fultz (C. I. 1923), Leap (C. I. 4823), and Stoner (C. I. 2980) wheat grown singly in pots in the greenhouse. Only those heads were chosen which contained a relatively large number of flowers in the stages of bloom indicated

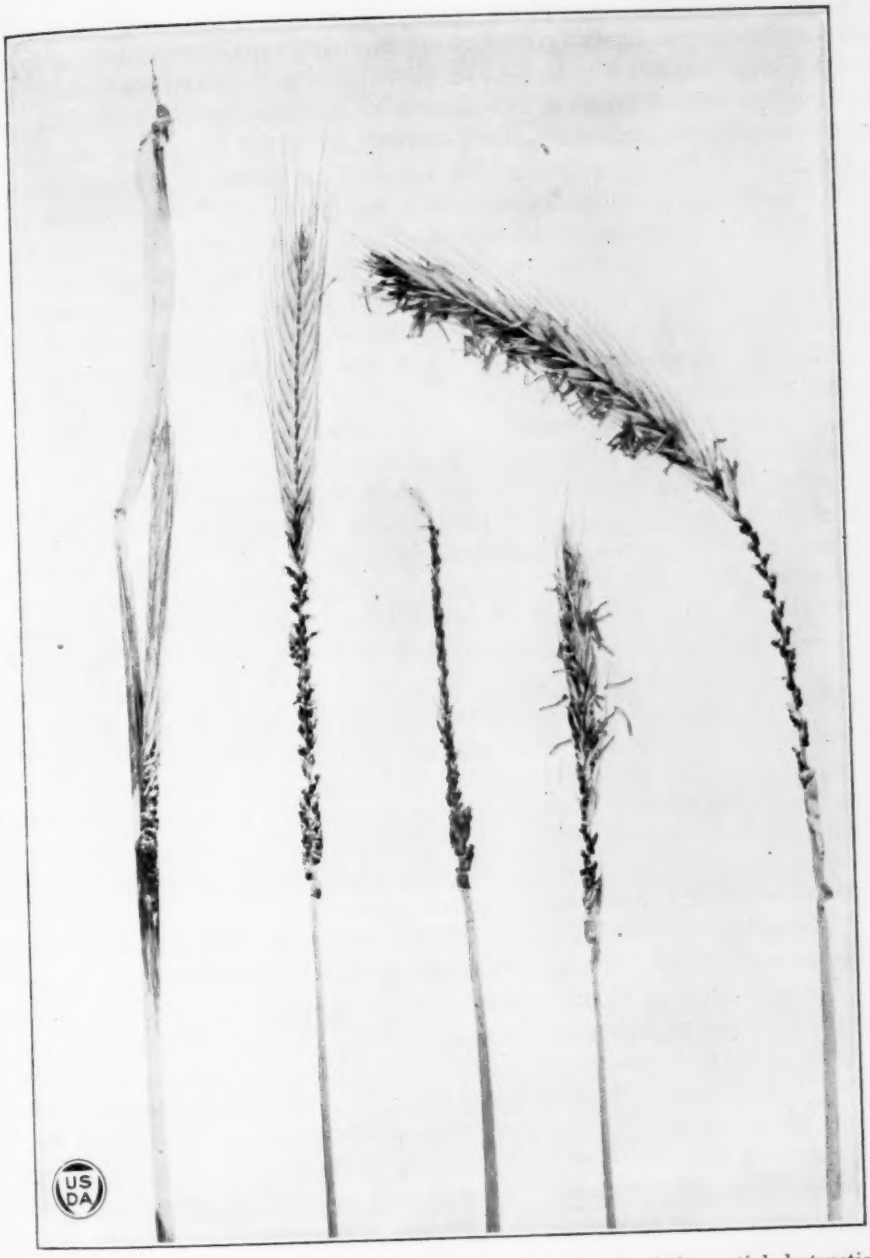

FIG. 2. Heads of rye infected with loose smut. The characteristic partial destruction of the head is here clearly shown. The seed from which these heads were grown was infected with *U. tritici* from wheat.

below. The flowers were gently opened with forceps, the tips of which had been dipped in a mass of smut spores from one or more heads of Rosen rye (C. I. 195), collected in the field on the day the inoculations were made. If the pollen of the flower was (1) about to be shed, as indicated by its color at maturity in the particular variety at hand, or (2) if the pollen was being shed, or (3) but recently shed, as indicated by a freshly plumose stigma and an ovary not noticeably enlarged, a small amount of inoculum was applied by lightly touching the stigma with the spore-laden tips of the forceps. All flowers not in the condition indicated in the foregoing were removed. The period of floral development within which the inoculations were made, therefore, fell within the limits determined by Freeman and Johnson (3) during which infection may take place in wheat flowers inoculated with spores of *Ustilago tritici*.

The inoculations were made at a time when no heads of wheat affected with loose smut were present in the near-by fields or greenhouses. However, in order to determine positively whether or not loose-smut infection might, by chance, have taken place naturally from spores blown into the greenhouse from without, several uninoculated heads were left to serve as controls on each of the plants which supplied heads for inoculation. After inoculation the plants were removed at once to an adjacent room, kept separately enclosed therein for one week, and then returned to the greenhouse. To serve as a control, a number of plants of Fultz (C. I. 1923) and Stoner (C. I. 2980) were inoculated in the greenhouse later on the same day, with loose-smut spores from freshly collected heads of Goens wheat, and the variety Leap (C. I. 4823) was similarly inoculated four days later. The technique here employed was precisely the same as that used in the above inoculations with loose-smut spores from rye. Following the inoculations of these plants, they too were removed to an adjacent room, kept separately enclosed therein for one week, and then returned to the greenhouse.

Methods were used in the inoculation of rye in 1922 similar to those described for wheat. Heads containing a relatively large number of flowers in the same stage of bloom as was described above were selected on plants grown in a plat at Arlington Experiment Farm, Rosslyn, Virginia. In one section of the plat, heads were inoculated with loose-smut spores from Rosen rye (C. I. 195) and, in another section of the plat, with loose-smut spores from Goens wheat. The diseased heads of wheat and rye used for sources of inoculum were collected in the field the same day the inoculations were made. When the inoculated rye heads were collected at maturity, a number of neighboring uninoculated heads also were collected in order to determine whether or not any loose-smut infection might have taken place naturally by means of spores blown from distant fields of wheat or rye.

Results.—Table 1 shows the following results: (1) High and similar percentages of infected plants and heads were obtained in wheat inoculated with loose-smut spores from wheat and from rye. (2) In rye, the percentages of infection also were about the same regardless of the source of inoculum. In all cases, the percentages of smutted heads of rye were less

FIG. 3. A greenhouse culture of wheat grown from seed infected with *U. tritici* from rye.

than 1 per cent when the plants were grown in the field. When grown under greenhouse conditions, however, the infection was more abundant.

The inoculation of rye with loose-smut spores from wheat was repeated in 1923 with some difference in method. Three or four heads, each on a near-by plant and each in approximately the same stage of development, were enclosed in a paper bag before anthesis of the flowers. The bagged plants were in plats of Rosen (C. I. 195) and Rimpau rye (C. I. 126). During the period of anthesis, a head was removed from each bag, inoculated, and immediately replaced. The inoculum consisted of loose-smut spores from Goens wheat, collected in the field on the day of inoculation.

TABLE 1.—*Number of plants and heads and number and percentages of smutted plants and heads of three varieties of wheat and two varieties of rye inoculated in the flowering stage with spores of loose smut from wheat or from rye, in 1922 and 1923, at Arlington Experiment Farm, Va.*

Crop and variety	C. I. No.	Source of inoculum	Date of inoculation	Inoculation in field or greenhouse	Crop, field or greenhouse	Number of plants		Percentage of smutted plants	Number of heads		Percentage of smutted heads
						Total	Smutted		Total	Smutted	
			1922								
Stoner wheat	2980	Rosen rye	May 18	Greenhouse	Greenhouse	43	28	65.12	94	46	48.94
do	do	Goens wheat	do	do	do	96	52	54.17	230	87	37.83
do	do	Not inoculated	.....	.....	do	60	0	0.00	.....	.....	.....
Fultz wheat	1923	Rosen rye	May 18	Greenhouse	do	78	43	55.13	218	105	48.17
do	do	Goens wheat	do	do	do	91	53	58.24	221	122	55.20
do	do	Not inoculated	.....	.....	do	57	0	0.00	.....	.....	.....
Leap wheat	4823	Rosen rye	May 18	Greenhouse	do	11	2	18.18	35	4	11.43
do	do	Goens wheat	May 22	do	do	86	8	9.30	274	10	3.65
do	do	Not inoculated	.....	.....	do	60	0	0.00	.....	.....	.....
Rosen rye	195	Rosen rye	May 18	Field	Greenhouse	38	8	21.05	162	12	7.41
do	do	Goens wheat	May 16	do	do	11	2	18.18	72	2	2.78
do	do	Not inoculated	.....	.....	.....	187	0	0.00	.....	.....	.....
do	do	Rosen rye	May 18	Field	Field	68	2	2.94	792	2	0.25
do	do	Goens wheat	May 16	do	do	15	1	6.67	171	1	0.58
do	do	Not inoculated	.....	.....	do	187	0	0.00	.....	.....	.....
			1923								
do	do	Goens wheat	May 22	Field	Greenhouse	22	0	0.00	103	0	0.00
Rimpau rye	126	do	do	do	do	157	3	1.91	475	4	0.84

The inoculated and uninoculated heads of wheat and rye were collected at maturity and thrashed by hand. In the greenhouse, the seed was sown at intervals of 2 inches in rows 6 inches apart on October 28, 1922, and November 13, 1923. In the field, the seed was sown at intervals of 7 inches in rows 1 foot apart on October 23, 1922. The results are presented in table 1.

VARIETAL SUSCEPTIBILITY

Reports on the occurrence of loose smut in rye have afforded no information as to the variety on which the disease was found.

In 1922, 1923, and 1924, the writers inspected all of the fortieth-acre agronomic plats of rye of the Office of Cereal Investigations at Arlington Experiment Farm. Each year a few heads of loose smut were found but only in the varieties Rosen (C. I. 195) and Rimpau (C. I. 126). Varieties in which no loose smut was found are the following: Abruzzes (C. I. 40), Abruzzes (C. I. 40–1), Giant Winter (C. I. 30), Henry (C. I. 138), Ivanoff (C. I. 34), Mexican (C. I. 108), St. Johns (C. I. 130), Virginia (C. I. 128–1), von Ruemker (C. I. 133), von Ruemker (C. I. 173), and Winter (C. I. 208).

SUMMARY

The occurrence of loose smut in rye was discovered in North Dakota in 1913 and recorded in 1914. Since then loose smut has been observed in Illinois, Indiana, Kentucky, Minnesota, Missouri, New York, Oklahoma, Tennessee, Virginia, and West Virginia.

Comparative cultural and microscopic studies of this smut and the loose smut of wheat failed to show any difference between them.

The reaction of the rye plant to invasion by *Ustilago tritici* is similar to that of wheat except that, in rye, total destruction of a part (often the lower third or half) of the head is the rule, while in wheat complete destruction of all florets is the rule.

Cross-inoculation experiments in which heads of both wheat and rye were inoculated with spores of loose smut from rye and from wheat, respectively, aided in establishing the identity of the two smuts.

Varietal-resistance observations indicate that of 13 varieties and selections only two, Rosen (C. I. 195) and Rimpau (C. I. 126), are susceptible.

OFFICE OF CEREAL INVESTIGATIONS,
BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

LITERATURE CITED

1. BAUHIN, KASPAR. Phytopinax. 669 p. Basileae. 1596.
2. FISCHER VON WALDHEIM, G. Aperçu Systématique des Ustilaginées.
3. FREEMAN, E. M., and EDWARD C. JOHNSON. The loose smuts of barley and wheat. U. S. Dept. Agr., Bur. Plant Indus. Bul. 152: 1–48. 1909.
4. GAINES, E. F., and F. J. STEVENSON. Occurrence of bunt in rye. Phytopath. 13: 210–215. 1923.
5. HUMPHREY, H. B. Recently discovered loose smut of rye (by title only). Jour. Wash. Acad. Sci. 4: 384. 1914.
6. RABENHORST, L. Uredo secales Rabenh., der eigentliche Roggenbrand, eine neue Pilzart. Flora 32: 209–211. 1849.
7. VAVILOV, N. I. Immunitet rastenii k infekcionnym zabolevaniyam. Bul. Petrovsk. Agr. Acad. 239 p. Moscow. 1918.

A STORAGE ROT OF PEACHES CAUSED BY A NEW SPECIES OF CHOANEPHORA[1]

E. D. Eddy

With One Figure in the Text

The recent investigations on the causal organisms of decays of fruits or vegetables during transit, storage, or at the markets, have brought the Mucorales to the attention of phytopathologists. Forms which were supposed to be mere saprophytes and worthy of little consideration by investigators of plant diseases are rapidly being added to the list of fungi capable of producing rots. With the exception of *Rhizophus nigricans* and *Choanephora cucurbitarum* (B. & Br.) Thaxter, species which have long been recognized as of importance as facultative parasites, the Mucors have been disregarded by the majority of writers on this subject.

Rhizopus nigricans is the most frequently found and most widely distributed species of this group. Its importance as the cause of plant diseases is partly due to great numbers of its spores which may be found anywhere in the air. Many other species of the Mucors, belonging to various genera, may produce decays of plant tissues under suitable environmental conditions. But they can never attain the same importance as the common "bread mold," as their spores are rarely present when such conditions occur in nature.

Storage rots have been attributed to a number of species of the genus *Mucor*. Harter in 1918 found that *Mucor racemosus* was the cause of a slow decay of sweet potatoes during storage at low temperature. *Choanephora cucurbitarum* is the causal organism of a soft rot of young squashes on the vines as well as of the mature fruit during storage. At the New York Markets Laboratory of the U. S. Department of Agriculture, isolations were made from the decayed fruits or vegetables which were found at the New York markets. Although inoculation experiments were not carried out in every case to prove the relation between the organism isolated and the rots, these isolations would indicate that a number of species should be considered as facultative parasites. At least six different species of *Rhizopus* were found causing decay. Four species of *Mucor* were obtained many times. *Choanephora cucurbitarum* was often isolated from squashes. And *Syncephalastrum racemosum* was twice isolated from decayed oranges.

[1] The work discussed in this paper was done in 1919 as a cooperative enterprise between the Office of Cotton, Truck, and Forage Crop Disease Investigations and the Bureau of Markets, United States Department of Agriculture, through the courtesy of the Director, Dr. G. S. Gager, in the laboratories of the Brooklyn Botanic Garden, Brooklyn, N. Y.

This paper deals with a new species of this group of fungi. It is closely related to *Choanephora cucurbitarum*. Although it may never become of serious importance on account of its limited distribution, it is of interest as another species of the Mucors which may develop as a facultative parasite and also because of its position in the systematic arrangement of these fungi.

The organism was isolated from decaying peaches found on the New York market by Dr. Mix during the summer of 1918. Pure cultures from a single spore were obtained and kept growing until the fall of 1919 before inoculations were made to determine whether it was the casual organism of this decay. Although this form has not been previously described, it is very similar or perhaps identical with a form isolated by Blakeslee and referred to by Thaxter[2] in his discussion of the various species of *Choanephora*.

The fungus grows well on various artificial media. A very slight white mycelial growth is noticeable covering the surface of the medium only during the first day or so of growth before the mycelium becomes black due to the formation of many small sporangia. The fertile hyphae arise directly from the surface of the substratum, without branching in any way, to produce a single spherical, black sporangium at the apex (Fig. 1C). This mode of growth largely determines its appearance in culture. On potato or malt-agar the growth is black and rarely more than $\frac{1}{8}$ inch high. It develops more luxuriantly on bread, reaching a height of from $\frac{1}{4}$ to $\frac{1}{2}$ inch. The fungus has been cultivated for eighteen months and still fruits just as abundantly in culture as it did when first isolated. It does not appear to lose its power of spore production when grown on artificial media as is the case with the other species of *Choanephora* that have been described. Chlamydospores of the fungus are illustrated in figure 1B.

The mycelium from these pure cultures was used for inoculating peaches to determine whether this species would produce a soft rot similar to that from which it was first isolated. The surfaces of seven healthy peaches were sterilized by dipping each fruit in alcohol to remove any air and then letting them stand for about five minutes in mercuric chloride solution (1:-1000). After this treatment they were rinsed thoroughly in sterilized water. Incisions through the skin were made with a flamed scalpel and bits of mycelium were inserted in each incision on five of the fruits. The two other peaches were not inoculated and served as controls. All the specimens were then placed in sterilized glass jars and kept at room temperature.

The five inoculated peaches were entirely decayed at the end of seven days and the fungus was fruiting abundantly over the surface, while the

[2] Thaxter, R., New or peculiar Zygomycetes, 3: *Blakeslea*, *Dissophora*, and *Haplosporangium*, nova genera. Bot. Gaz. **58**: 353–366. 1914.

two control specimens had remained in perfect condition. The rot first appeared on the second day as a small discolored and softened area on the surface immediately surrounding the point of infection. A soft brown decay spread rapidly, involving the entire fruit in from four to six days after its first appearance. The sporangia developed on the surface forming a low black felt about an eighth of an inch thick. There was no white mycelial growth, "whiskers," over the surface as is commonly the case with *Rhizopus nigricans* or *R. reflexus* when growing under moist conditions. Although softened, the tissues remain fairly firm and do not collapse and "leak," as when decayed by species of *Rhizopus*.

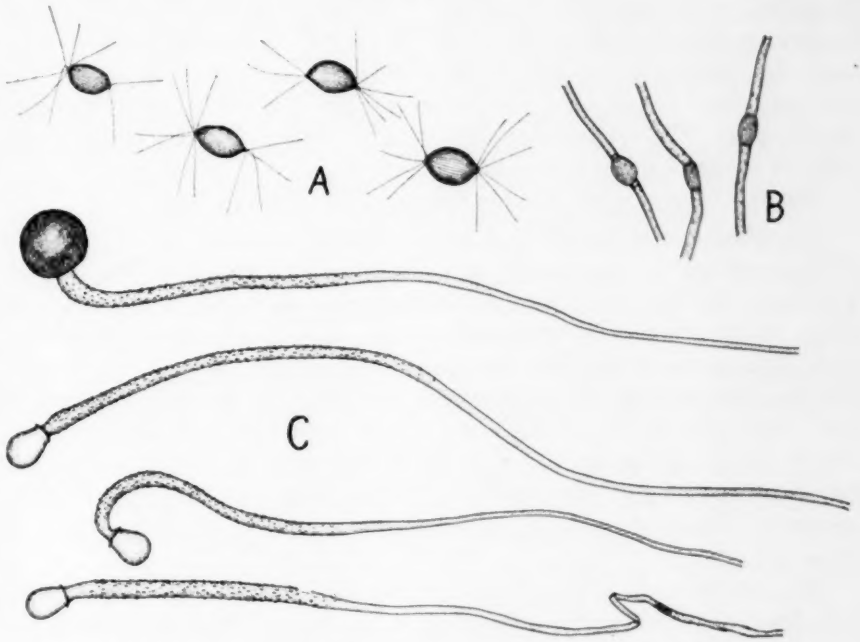

FIG. 1. *Choanephora persicaria*. A, Four spores, magnified 870 diameters; B, Chlamydospores, magnified 385 diameters; C, Four fertile hyphae showing sporangia and columellae of *Choanephora persicaria*, magnified about 49 diameters.

Choanephora persicaria was thus shown to be a facultative parasite, capable of producing a soft rot of peaches under experimental conditions. Infection may occur through a bruise or cut when the environmental conditions are such that the injured surface remains moist and penetrable long enough for the spores to germinate and the hyphae to enter the tissues. Experiments were not tried to determine whether this fungus might penetrate an uninjured surface. The results would probably be negative as with the other forms of the Mucorales which act as facultative parasites.

Choanephora persicaria n. sp.

Mycelial growth low, black, 2.5–12 mm. high. Fertile hyphae rising directly from the mycelium, erect, unbranched, 0.5–2 mm. high, terminated by a single sporangium, outer surface conspicuously roughened in upper half of its length and distinctly swollen. Sporangia spherical, erect, nodding or circinate, variable, 64–128 μ in diameter, average 100 μ. Sporangial membrane covered with fine crystals, dehiscent and not quickly diffluent, having a narrow collar at the base of the columella. Columella elongated, constricted at the base, pyriform to globose, hyaline, 76–121.5 μ long × 49–83.6 μ broad, very variable in shape and size. Spores oval or elliptical, elongated, often irregular in shape, indistinctly longitudinally striated, hyaline or very slightly darkened, 19–22 × 11–15 μ, bearing a few exceedingly fine, radiating appendages in groups at either pole. Length of appendages equal to that of the spores or greater. "Conidia" or sporangiola not observed. Chlamydospores cylindrical, hyaline, 15–26.6 × 11–16 μ, very variable in shape and size, and not numerous.

Isolated from decayed peaches found on the New York market.

The affinities of *Choanephora persicaria* are certainly with the species of *Choanephora* that have so far been described and with *Blakeslea trispora* Thaxter. The spores of both of these genera show the fine appendages which radiate from either pole and also the strictions on the surface (Fig. 1A). The spores of the other species are colored, purple or reddish-brown. The circinate normal sporangia, which are produced in great numbers in this form, very closely resemble the normal sporangia produced occasionally by the other species. But in this species only one type of sporangia has been found, while the "conidia," the stage usually developed in other species of *Choanephora*, or the sporagiola as found in *Blakeslea*, have not appeared.

Thaxter refers to a strain showing this same characteristic and writes: "At least one species of Choanephora is known to the writer which was isolated by Blakeslee during his investigations on the Mucorales, and has never been seen to produce anything but normal sporangia with the typical appendiculate spores of this genus, although it was kept in cultivation for a period of years."

A number of attempts were made to induce the development of another spore-form, "conidia" or sporangiola, by growing the organism in open dishes in order to lessen the degree of humidity, as in related forms the "conidial" stage develops best, or only under dry conditions or in a free circulation of air. None but "normal sporangia" have been found in any cultures. The apparent absence of any "conidial" stage in this species is not sufficient basis for a separation from the species which it so closely resembles in all other characteristics.

The writer wishes to acknowledge his indebtedness to Dr. Mix, who isolated this fungus, and to Dr. Roland Thaxter for valuable suggestions.

PRELIMINARY STUDIES ON THE CONTROL OF CEREAL RUSTS BY DUSTING

C. V. KIGHTLINGER

During the season of 1924 the writer undertook some experimental work on the use of fungicidal dusts in the control of cereal rusts. The results of these preliminary studies are so striking and promising that it seems desirable to present a brief summary for the benefit of other workers interested in the problem of cereal rust control.

While in its broader aspects the problem might well have involved control by the application of fungicidal protectants in any form, spraying was excluded because of its evident impracticability. The use of a fungicidal dust seemed most likely to yield results of practical value.

Knowing that sulfur had proved effective as a protectant against rust infection in two well established cases (the rusts of asparagus and of snapdragons), it was believed that most probably sulfur would prove effective as a protectant against rust in the case of cereals. After numerous laboratory tests on the inhibitory effects of several sulfur dusts on the germination of uredospores of *Puccinia coronata* it was decided to use dusting sulfur. The dust used was 90–10 sulfur lead arsenate dust, because it was the only kind on hand in quantity when dust was needed. However, it is not assumed that the lead arsenate contained in the dust had any marked fungicidal value.

The aim of the work was to determine whether or not sulfur would prevent rust infection of cereals. This part of the work fell naturally into three phases: (1) laboratory studies on spore germination in relation to the fungicidal efficiency of sulfur dusts, (2) dusting tests in the greenhouse on growing plants, (3) tests of the efficiency of dusts on plants under field conditions. The results obtained from the laboratory tests on germination of uredospores in drop cultures on dusted and undusted slides afforded data for the study of the comparative values of the several dusts with respect to their inhibitory effects. It also provided a criterion for the elimination of the less desirable forms in future work. An average of 72.9 per cent germination of uredospores of *P. coronata* was obtained in checks as against 18.8 per cent on the slides dusted with the 90–10 mixture. However, these results were not held to be absolutely the same as those which might be obtained in the field, although past experience with this method, originally developed by Wallace and Reddick, has shown it to be very reliable in this respect.

Among other things of interest observed in the germination tests was the fact that the germ-tubes produced on slides dusted with sulfur were

shorter than those in the checks. Those on slides dusted with 90–10 dust, averaged 35 μ in length and those with precipitated sulfurs 58.123 μ, while in the case of the check the average length was 116.5 μ. It was further noted that the germ-tubes produced on dusted slides were very much distorted and vacuolate, and very unevenly granular, indicating, it seemed, that the fungicide while not entirely preventing germination was decidedly injurious to those germ-tubes which did form. It appeared probable that such germ-tubes could never produce infection. This was later confirmed by the greenhouse and field tests. Spores nearest the edge of the drops where they came in closest contact with the sulfur particles seldom, if ever, germinated.

In the greenhouse work 90–10 dust only was used. The larger part of the work in the greenhouse was conducted with *P. coronata* on oats though tests with *P. graminis avenae* gave equally good results. The oats for these tests were grown in pots. They were dusted with the same duster with which the slides in the laboratory had been dusted so that the applications on slides and leaves were approximately equal as to amounts per unit area. After the plants had been dusted, the spore suspension was applied with an atomizer, following which the plants were placed in a moist chamber for as long a time as appeared necessary, depending upon the conditions obtaining at the time of the treatment.

With these pot cultures striking results were obtained. Out of a total of 2,071 inoculated plants 1,057 were dusted, and 1,014 not dusted. The 1,057 dusted plants showed but two lesions or sori, while the 1,014 non-dusted ones showed 4,517 sori.

The results obtained from these greenhouse tests were extremely suggestive and stimulating. In order to determine whether the results obtained in the greenhouse could be duplicated or approximated under field conditions, experiments were made during the spring and summer (1924) in field plots. These tests were necessarily confined to oats. Thirteen plots slightly larger than one square rod each were planted, arranged alternately in checker-board fashion with respect to checks and treated plots. There were six treated plots and seven not treated. All six of the treated plots received the first four applications of 90–10 dust, one plot received one additional dusting, and two received two additional applications. No attempt was made to apply any definite amount of dust per application, as the object was to determine only the effectiveness of sulfur in preventing rust infection. The applications were made just before rains as far as possible.

Artificial inoculation was made first by applying spore suspensions to the plants of all the plots by atomizer, and later by interplanting infected

oats alike in two checks and in two treated plots. Heavy and general infection followed in the undusted plots.

A count of infected plants versus non-infected plants in plot 3 (check) and plot 4 (dusted) revealed phenomenal control. All plants in each plot were counted. In the dusted plot there was .03 per cent infected plants while in the checks (untreated) there was 74.35 per cent infected plants. An idea of the degree of control secured in all the plots can best be obtained by consulting the following table, for which counts of all the plants in five central rows of each plot are given.

Plot	No. of applications	Per cent of infected leaves
1a	0	93.35
1	7	0.08
2	0	42.50
3	0	99.14
4	7	0.00
5	5	0.26
6	0	73.02
7	0	98.40
8	4	21.23
9	4	14.60
10	0	90.30
11	0	90.00
12	4	12.60

In conclusion, the writer would point out that the results given are purely of preliminary value and not to be used as the basis for recommendations for the practical control of cereal rusts. More extensive field tests, not only on oats but also on wheat and rye, are under way this season.

CORNELL UNIVERSITY,
ITHACA, N. Y.

MISTLETOE IN THE LOWER BOLE OF INCENSE CEDAR

WILLIS W. WAGENER

Irregular fusiform or barrel-shaped swellings are frequently found on the upper parts of the bole of Incense cedar, one of the important forest constituents of the California pine region. These swellings were first investigated by Meinecke[1] who found them to be caused by old established growths of the Incense cedar mistletoe, *Phoradendron libocedri* Howell. He pointed out that the development of the swellings was accompanied by a very remarkable change in the habit of the mistletoe. As the bark of the Incense cedar thickens, the green shoots of the mistletoe are pushed out with increasing difficulty until finally they become completely smothered and the mistletoe plant adapts itself to life as a true parasite in the tissues of the host tree. In this form the mistletoe attains ages much greater than known for other members of the genus or its Old World relative, *Viscum*. The resulting swellings develop to large size. Meinecke found one swelling in which the parasite had been present for 219 years. In point of size the largest measured by him was a barrel-shaped swelling 5 feet 8 inches in length.

Mistletoe is not the only cause of swellings on Incense cedar. As shown by Boyce,[2] enlargements of the trunk and branches may be due to the presence of the perennial mycelium of a rust, *Gymnosporangium blasdaleanum* (D. & H.) Kern. Due to their somewhat similar apparance, these may be confused with *Phoradendron* swellings from which green shoots are no longer produced, but the two can ordinarily be distinguished by their comparative size and shape.

The *Phoradendron* swellings are usually rather large and thick, while the swellings caused by the rust are smaller and very much narrower in outline. Typically, the latter are of a narrow spindle shape or, as described by Boyce, they resemble "the muscles of the upper arm when partially contracted."

Swellings from both causes occupy about the same range of position in the tree. The berries of the mistletoe are chiefly disseminated by birds which do not appear to frequent small Incense cedars. Should a berry by chance become lodged in a small tree, or in the shaded lower crown of a larger one, it evidently does not find conditions favorable for its establish-

[1] Meinecke, E. P. Parasitism of *Phoradendron juniperinum libocedri* Engelm. Proc. Soc. Am. For. 7: 35–41. 1912.

[2] Boyce, J. S. Perennial mycelium of *Gymnosporangium blasdaleanum*. Phytopath. 8: 161–162. 1918.

ment. As a rule, therefore, the Incense cedar mistletoe is found well up in older trees. *Gymnosporangium blasdaleanum* on the other hand very commonly occurs on small young trees but seems to die out as the trees grow older, as *Gymnosporangium* swellings are rare for the first log length on the boles of larger Incense cedars.

A swelling which varied markedly from the usual position for either *Phoradendron* or *Gymnosporangium* was found recently near Cow Creek on the Stanislaus National Forest, California, the same general locality from which Meinecke reported the *Phoradendron* swellings described by him. It occurred on an old Incense cedar, 50 inches in diameter inside bark at stump height, growing in a mixed coniferous stand at about 5,000 feet elevation. From a point 2 feet above ground up to 10.5 feet, one side of the trunk of this tree was swollen in an irregular spindle shape, with the region of greatest swelling at 5.3 feet from the ground. Here the swollen part measured 4.4 feet over the outside and occupied about 130° of the circumference of the tree. In the process of enlargement, the basal fluting, characteristic for the trunks of old Incense cedars, had been strongly accentuated, resulting in a division of the swelling by deep, longitudinal furrows into several ridges, widely expanded toward the outside over a rather narrow base. The location of the swelling suggested *Gymnosporangium blasdaleanum* as the casual organism, though it was considerably larger than any previously reported even for *Phoradendron libocedri* swellings. There were no surface indications to aid in a positive determination, but, upon the removal of a portion of bark from one of the ridges, rows of depressions in the wood were uncovered, from which projected the yellowish outer ends of living mistletoe sinkers, proving that the enlargement was not in fact due to *Gymnosporangium* but to the Incense cedar mistletoe. As far as is known this is the first reported case of the occurrence of *Phoradendron libocedri* so near the ground.

The mistletoe must have gained entrance while the host tree was still quite young. Under the assumption that the height at which entrance took place would be indicated approximately by the greatest degree of enlargement, a cross section cut was sawed through the thickest part of the swelling at 5.3 feet from the ground. The innermost sinker was found in the heartwood at about 7 inches from the center of the tree. The diameter of the tree at this point was thus 14 inches inside bark at the time the mistletoe appeared there. It would be impossible for a mistletoe seedling to penetrate the thick bark on so large a trunk. Both this fact and the absence of any signs of the bases of former mistletoe shoots in the wood at the cross section indicated that the cut had not passed through the point of initial entrance of the mistletoe. It is not unlikely that entrance was

effected through the base of a nearby branch and that later the parasite gradually spread into the main trunk.

Allowing for several rings which could not be counted on account of rot in the center heartwood, the age of the tree at the cross section was about 448 years. Ring counts established the age of the mistletoe plant at this point at 409 years. Actually it must have been present for a number of years longer. Even 409 years is 200 years in excess of the greatest age recorded by Meinecke for the cases examined by him.

Phoradondrons, when young and vigorous, are known to have severely deleterious effects on their hosts, as is well illustrated in our Sierra forests by the spiked and broken tops found in White fir as the result of the presence of *Phoradendron pauciflorum*. Young plants of *Phoradendron libocedri* are not unlike other Phoradendrons in this respect, though their effect does not appear to be quite so severe as for some of the other species. As they grow older and gradually assume a truly parasitic character, the change appears to be accompanied by a general lowering of physiological requirements which results in little harm to the host. The merchantability of affected trees, however, is often seriously reduced.

In the parasitic form the mistletoe is apparently able to live on indefinitely, and there is no evidence that the natural life of the host is shortened by its presence. Incense cedar being a long-lived tree, *Phoradendron libocedri* is able to attain remarkably high ages. It would not be surprising if living specimens even older than the one described here were found.

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
SAN FRANCISCO, CALIF.

PHYTOPATHOLOGICAL NOTES

Peridermium Harknessi Moore in Western Yellow Pine Tops.—Peridermium harknessi generally attacks seedlings and saplings most heavily, and seldom reaches above the lower branches of larger trees. An unusual case was found in 1924 on the Stanislaus National Forest, California, at an elevation of 5,000 feet, in which several good-sized Western Yellow pines were carrying the fungus in their tops. A group of four or five vigorously growing standards about 100 feet tall bore a number of galls in their crowns, above a height of 75 feet. The swellings ranged from 3 to 7 centimeters in diameter, and though most of them were dead, a few were still sporulating at the time of the observation early in October. At distances of 50 and 125 yards respectively from this group, stood two more infected trees, both about 150 feet tall. Each had a single sporulating gall on the leader within 3 feet of the tip. All of these pines were more or less aligned in the direction of the locally prevailing summer winds. About 200 yards away, though not strictly in line with the above, one other dead gall had been found earlier in the season. It was on a branch among the top litter of several felled trees which had formed part of a clump of suppressed individuals from 60 to 80 feet tall. The original height of the swelling could not be determined accurately, but it must have been supported at least 50 feet above ground.

The infected trees were located on a timber sale in a mature Sugar pine-Yellow pine stand, with a fairly rich understory of various-aged Yellow pine reproduction. The field work incidental to their discovery lasted for three and a half months from July to October, 1924. During this time every felled pine on a hundred acres of the logging operation was carefully examined. Constant attention also was given to the pathology of the young growth in the region. No more galls were observed and even *Castilleia* and *Pedicularis*, which were occasionally present, failed, after frequent examinations throughout the season, to reveal any signs of a *Cronartium*.

There is a bare possibility that the absence of uredinia and telia was due to the excessive drought of 1924, which may have hastened the fruiting period or inhibited it altogether. The apparent freedom of young Yellow pine from the disease rather seems to speak against the existence of an endemic condition of long standing based on local inter-relations between Scrophulariaceous hosts and pines. It seems far more probable that the infection, isolated within a large area and running in a well defined streak high above ground, had originated in the stand from chance sporidia or aeciospores carried in from the outside. Once established, the rust spread from pine to pine by direct aecial infection.—L. S. Gill.

Office of Investigations in Forest Pathology,
Bureau of Plant Industry, U. S. Dept. of Agr.,
San Francisco, Cal.

AMERICAN PHYTOPATHOLOGICAL SOCIETY

CONSTITUTION

ARTICLE I

This Society shall be known as The American Phytopathological Society.

ARTICLE II

MEMBERSHIP

SEC. 1. The Society shall consist of members, and may include sustaining life members and patrons.

SEC. 2. The charter membership of this Society shall consist of the one hundred and thirty persons who accepted the invitation of the Organization Committee of October 25, 1909, to form the Society.

ARTICLE III

QUALIFICATIONS FOR MEMBERSHIP AND DUES

SEC. 1. All persons interested in the study of phytopathology, including the practical control of plant diseases, shall be eligible to membership.

SEC. 2. Each member shall pay annually such dues as the Society shall determine.

SEC. 3. Any member may become a sustaining life member by paying one hundred dollars in ten consecutive annual payments, and any person may become a patron upon the payment of one hundred dollars, and upon election shall have all the privileges of membership.

ARTICLE IV

ELECTION OF MEMBERS

Members may be elected at any regular meeting of the Society or by the Council during the interim. Applications for membership must be endorsed by at least one member of the Society.

ARTICLE V

OFFICERS

The officers of the Society shall consist of a President, Vice President, and Secretary-Treasurer. Their duties shall be those usually performed by such officers. The President and Vice President shall serve for one year and the Secretary-Treasurer for three years, or until their successors are elected, and the Council shall fill any vacancies occurring in the interim between elections.

The Council shall consist of the President, Vice President, Secretary-Treasurer, the retiring President, and the Chairman of the Board of Editors of the Journal of the Society, with two members elected, one each year, who shall serve for a term of two years, and one member elected annually by each Division. All action of the Council or officers must be authorized or approved by the Society.

ARTICLE VI

ELECTION OF OFFICERS

Officers shall be elected by a majority vote of the members present at the regular annual meeting.

ARTICLE VII

EDITORS AND COMMITTEES

The Editors of the official organ of the Society shall be selected by the Council subject to the approval of the Society. Temporary or standing committees may be appointed at the discretion of the Society.

ARTICLE VIII

MEETING

An annual meeting shall be held at such a time and place each year as the Council may select, and additional meetings, including special or local meetings, for the presentation of papers, may be arranged by the Council at its discretion.

ARTICLE IX

AMENDMENTS

This Constitution may be amended at any annual meeting by a three-fourths majority of all the members voting, notice of the proposed amendment having been sent to all the members at least one month previous to the meeting.

PROPOSED AMENDMENTS TO CONSTITUTION

The following amendments to the Constitution were submitted at the Washington Meeting and will be voted on at the Kansas City Meeting December 29, 1925, to January 1, 1926.

A. Change Article VI to read as follows:

ARTICLE VI

ELECTION OF OFFICERS

The Secretary-Treasurer shall send nomination ballots for offices to each member of the Society in time to allow all nominations to be returned

not less than two months before the date of the annual meeting. The Council shall make nominations for any office when such nominations are wanting. The three candidates for each office receiving the highest number of nominating votes shall be placed upon a final ballot, which shall be sent to each member one month before the annual meeting. Votes shall be mailed to the Secretary-Treasurer and canvassed by the Council. A plurality vote shall elect.

B. Add the following article:

ARTICLE IX

DIVISIONS

Branch organizations or units within the Society known as Divisions may be established on a geographical basis, provided formal application setting forth the reasons for the establishment of the Division is made to, and approved by, the parent Society.

C. Amend Article V by inserting the following immediately before the last sentence of the Article:

The term of service of a council member from a Division shall commence at the beginning of the annual meeting of the Society next following his election by the Division.[1]

D. Change the number of the present Article IX (Amendments) to Article X.

STANDING RULES[2]

The rules under which the American Phytopathological Society operates are as follows:

PHYTOPATHOLOGY

1. The official publication of the Society shall be *Phytopathology*.

Officers

a. The officers of *Phytopathology* shall be an editor-in-chief, term three years; two editors, terms three years; twelve associate editors, terms three years, four selected each year; business manager, term one year; and advertising manager, term one year.

Selection of Officers

b. The editor-in-chief and the business manager shall be selected by the Council and ap-

[1] Note that Article V, paragraph 2, was amended at the Baltimore Meeting by adding at the end of the first sentence the words "for a term of two years and one member elected annually by each Division." (Phytopath. 9: 1–86. 1919.)

[2] Submitted by Committee on Codification of Rules and adopted by the Society at the Washington meeting, January 1, 1925.

proved by the Society. The editors and the twelve associate editors shall be selected by the Council in consultation with the editor-in-chief and approved by the Society. The advertising manager shall be selected by the Council in consultation with the business manager and approved by the Society.

Subscriptions, Back Numbers

c. Subscriptions to *Phytopathology* for institutions and non-members shall be $5 per year in the United States and dependencies, Mexico, and Cuba; Canada $5.25; other countries $5.50. The price of current single numbers shall be 50 cents. Back volumes with the exception of volumes 4, 5, and 6 may be obtained unbound at $6 per volume, postage paid. Separate copies will not be sold except in cases where the volumes are already broken, the price of such copies shall be $1 for each number in volumes one to seven inclusive, and 50 cents each for subsequent years. Requests to supply lost copies of the journal without charge must be made within sixty days from date of issue.

DUES

2. The annual dues for each regular member including subscription to *Phytopathology* shall be $4 per year, payable on December 20. The business manager of *Phytopathology* shall discontinue sending the journal to any members whose dues have not been received by December 20.

PAPERS, ABSTRACTS

3. Members desiring to present papers at the annual meeting must furnish to the secretary carefully prepared abstracts presenting as clearly and concisely as possible the substance and conclusions of the papers, these abstracts to embody definite results and not to exceed two hundred words in length.

Date Due

a. The secretary is authorized to refuse abstracts received by him after the date on which they are due (Nov. 15). Members are requested not to submit titles or abstracts unless they intend to be present at the meetings.

Number of

b. No member shall be permitted to present more than two papers at any one meeting except by invitation, and in case of joint authorship the paper shall be charged to the author presenting it.

Editing of

c. All abstracts shall be submitted to an editorial committee of at least three selected by the editor-in-chief of *Phytopathology* and this committee will edit the abstracts in the same manner as original articles published in *Phytopathology*.

PROGRAMS

4. The program for the annual meeting shall be in charge of a program committee consisting of the president, secretary, and chairman of the Advisory Board. To relieve congestion the program committtee is authorized to schedule simultaneous sessions when necessary.

DIVISIONS

5. The following provisions shall govern the organization and regulation of Divisions of the Society.

Name of

a. Divisions shall use the name of the parent society with the appropriate geographical term, for example, American Phytopathological Society, Pacific Division.

Membership

b. Divisions shall elect to full membership only members of the American Phytopathological Society, but each Division may elect associate members under such rules as it may adopt.

Publication

c. The proceedings of Divisions shall be printed in *Phytopathology*. The preliminary abstracts of the Division meetings may, at the discretion of these Divisions, be printed in *Phytopathology* under the same rules that govern publication of abstracts of the general society. This rule, however, shall not be interpreted as limiting the present right of the Editorial Board of *Phytopathology* to define the character and amount of any manuscript for publication.

Meetings of

d. Whenever the American Phytopathological Society meets within the territory of a Divi-

sion, the Division shall merge its program with that of the parent Society. The scientific sessions of such a meeting shall be presided over alternately by the president of the American Phytopathological Society and the president of the Division. Business sessions may be independent.

Constitution of

e. The constitution or articles of organization of all Divisions shall contain a provision or provisions ratifying the above rules. The constitution of all Divisions shall contain nothing in conflict with the constitution of the American Phytopathological Society. With the exceptions defined by the above rules the Divisions shall enjoy complete autonomy.

SECRETARY'S EXPENSES

6. Unless otherwise ordered the secretary is authorized to attend the annual meetings of the Society at the Society's expense.

AUDITING COMMITTEE

7. At each annual meeting the president shall appoint an auditing committee to audit the accounts of the secretary-treasurer and the business manager of *Phytopathology*.

ADVISORY BOARD

8. There shall be a permanent committee of the Society called the Advisory Board working under the direction of and reporting to the Council. The personnel of this board shall be eight members appointed by the Council, two each for periods of one, two, and three years, and thereafter two each year for a three-year term, these members to represent the United States Department of Agriculture and the following regions—Northeast, South, Middle West, Pacific Coast, and Canada; and two members at large for terms of three years. The chairman of the Board shall be elected annually by the Board.

Duties of

The duties of the Board shall be:

a. To represent the American Phytopathological Society before the National Research Council. The chairman of the Board shall be the Society's representative on the Division of

Biology and Agriculture of the National Research Council.

b. To function as the committee on cooperation with the Crop Protection Institute and the Tropical Research Foundation.

c. To arrange for conferences of groups of workers on related subjects at the annual meetings or elsewhere.

d. To confer with workers in related fields, i e., entomology, genetics, horticulture, and agronomy, to promote joint efforts on our common problems.

e. To promote international relations in phytopathology.

f. To take up such other problems as the Board may find desirable, subject to the approval of the Council.

UNION OF BIOLOGICAL SOCIETIES

9. The society shall participate in the work of the Union of American Biological Societies and designates its secretary and editor-in-chief of *Phytopathology* as its representatives unless otherwise voted.

BOTANICAL ABSTRACTS

10. The Society shall elect two representatives on the Board of Control of *Botanical Abstracts* for terms of four years each, one being chosen every other year.

CROP PROTECTION INSTITUTE

11. Representation on the Board of Governors of the Crop Protection Institute shall be provided for by three trustees, with three year terms, one selected each year, these trustees to be chosen by the Council, with the proviso that one of them shall also be a member of the Advisory Board of the Society.

OTHER REPRESENTATIVES

12. The following shall be selected by the Council and approved by the Society: two representatives on the Council of American Association for the Advancement of Science for one year terms; one trustee on the Tropical Research Foundation for a five year term, and one member of the Editorial Board of the American Journal of Botany for a three-year term.

AMENDMENTS

13. These rules may be amended by a majority vote of the members voting at any regular meeting of the Society.

LIST OF PATRONS AND MEMBERS

SEPTEMBER 1, 1925.

PATRONS

CAPP, S. B., P. O. Box 2054, Philadelphia, Pennsylvania.

DAVIS, J. J., Curator of Herbarium, University of Wisconsin, Madison, Wisconsin.

DELAFIELD, MATURIN L., 29 Avenue Davel, Lausanne, Switzerland.

JACZEWSKI, A., Director, Institut Jaczewski de Mycologie et Pathologie vegetale, Petrograd, Russia.

VAVILOV, N. I., Director, Bureau of Applied Botany and Plant Breeding, Morskaja, 44, Petrograd, Russia.

MEMBERS

AAMODT, OLAF S., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University Farm, St. Paul, Minn.

ABBOTT, HOWARD C., Department of Biology, University of South Dakota, Vermillion, S. Dak.

*ADAMS, JAMES FOWLER, Associate Plant Pathologist, Agricultural Experiment Station, University of Delaware, P. O. Box 425, Newark, Del.

ALLEN, RUTH F., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 208 Hilgard Hall, Berkeley, Calif.

AMES, ADELINE, Department of Biology, Sweet Briar College, Sweet Briar, Va.

ANDERSON, C. GEORGE, Taujica District, Puerto Castilla, Spanish Honduras, C. A.

ANDERSON, EMMA N., Assistant Professor of Botany, University of Nebraska, Bessey Hall, Lincoln, Nebr.

†ANDERSON, HARRY WARREN, Assistant Chief, Pomological Pathology, University of Illinois, Urbana, Ill.

ANDERSON, JACOB PETER, Box 1074, Juneau, Alaska.

†ANDERSON, PAUL J., Plant Pathologist, Connecticut Tobacco Experiment Station, Windsor, Conn.

ANGELL, HERBERT R., Department of Plant Pathology, University of Wisconsin, Madison, Wis.

ARMSTRONG, GEORGE M., Division of Boll Weevil Control, Clemson Agricultural College, Pee Dee Experiment Station, Florence, S. C.

ARNDT, C. H., c/o Service Technique, Port au Prince, Haiti.

ARNOLD, CHESTER A., Assistant in Botany, Cornell University, Ithaca, N. Y.

ARTHUR, J. C., Emeritus Professor of Botany, Purdue University, LaFayette, Ind.

ARTSCHWAGER, E. F., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

* Life sustaining members paying currently.

† Life sustaining members who are paid up for life.

ARZBERGER, E. G., Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ATANASOFF, D., Faculty of Agriculture, University of Sofia, Bulgaria.

ATWELL, E. A., Macdonald College, Macdonald College P. O., Quebec, Canada.

AYERS, THEODORE T., Investigator in Botany, Massachusetts Agricultural College, Clark Hall, Amherst, Mass.

BACH, WALTER J., Box 1058, Orlando, Fla.

BAHGAT, MONIR, Graduate Student, University of California, Box 388, Berkeley, Calif.

BAILEY, DIXON LLOYD, Pathologist, Dominion Laboratory of Plant Pathology, Manitoba Agricultural College, Winnipeg, Manitoba, Canada.

BAIN, HENRY FRANKLIN, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BAIRD, EDGAR ALAN, Associate Professor of Botany, University of North Dakota, Grand Forks, N. Dak.

†BALLARD, WILLIAM SALISBURY, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BARIBEAU, BERNARD C. H., Potato Supervisor for the Province of Quebec, Plant Pathological Laboratory, Ste. Anne de la Pocatiere, P. Q., Canada.

BARINGER, JOHN WILLIAM, Associate Pathologist, U. S. Department of Agriculture, Botany Department, Ohio State University, Columbus, Ohio.

BARKER, HENRY D., Botanist and Plant Pathologist, Service Technique, Port au Prince, Haiti.

*BARRE, HENRY WALTER, Professor of Botany and Plant Pathology and Director of Research, Clemson College and South Carolina Experiment Station, Clemson College, S. C.

†BARRETT, JAMES THEOPHILUS, Professor of Plant Pathology, Associate Director University of California Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, Calif.

†BARRUS, MORTIER FRANKLIN, Professor of Plant Pathology, New York State College of Agriculture, Cornell University, Ithaca, N. Y.

*BARSS, HOWARD PHILLIPS, Professor of Botany and Plant Pathology and Botanist and Plant Pathologist of the Experiment Station, Oregon State Agricultural College, Corvallis, Ore.

BARTHOLOMEW, ELBERT THOMAS, Assistant Professor of Plant Pathology, University of California Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, Calif.

BATSON, MRS. ELANORE, Medical College, Eden and Bethesda Avenues, Cincinnati, Ohio.

BAXTER, DOW VAWTER, Instructor, Botany Department, University of Wisconsin, Madison, Wis.

*BEACH, WALTER SPURGEON, Associate Professor of Plant Pathology, Pennsylvania State College, Bustleton, Philadelphia, Pa.

*BEATTIE, R. KENT, Pathologist in Charge Foreign Plant Quarantines, Federal Horticultural Board, U. S. Department of Agriculture, Washington, D. C.

BECKWITH, ANGIE M., Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BENNETT, CARLYSLE WILSON, Department of Botany, Michigan Agricultural College, East Lansing, Mich.

BENNETT, J. P., 331 Hilgard Hall, University of California, Berkeley, Calif.

BERG, ANTHONY, Assistant Plant Pathologist, Agricultural Experiment Station, Morgantown, W. Va.

BERGMAN, HERBERT FLOYD, Professor of Botany, University of Hawaii, Honolulu, T. H.

BERKELEY, GARVEN H., Plant Pathologist, Dominion Laboratory of Plant Pathology, 204 St. Paul Street, St. Catherines, Ontario, Canada.

BERKHOUT, CHRISTINE MARIE, Research Worker, Cornell University, Ithaca, N. Y.

BESSEY, ERNST ATHEARN, Professor of Botany, Michigan Agricultural College, East Lansing, Mich.

BETHEL, ELLSWORTH, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, State Museum, Denver, Colo.

*BISBY, GUY RICHARDS, Professor of Plant Pathology, Manitoba Agricultural College, Winnipeg, Canada.

BLAIN, WALTER L., Associate Plant Pathologist and Associate Professor of Plant Pathology, Alabama Polytechnic Institute, Auburn, Ala.

*BLAIR, R. J., Springdale Farm, Ormstown, Quebec, Canada.

BLAKESLEE, ALBERT FRANCIS, Plant Geneticist, Station for Experimental Evolution, Carnegie Institution of Washington, Cold Spring Harbor, N. Y.

*BLODGETT, FOREST MILO, Assistant Professor, College of Agriculture, Cornell University, Ithaca, N. Y.

BOLLEY, HENRY L., Botanist and Plant Pathologist, State Seed Commissioner, Dean of Biology, North Dakota Agricultural College, Agricultural College P. O., N. Dak.

BONAR, LEE, Instructor in Botany, University of California, Berkeley, Calif.

BONDE, REINER, Assistant Plant Pathologist, Maine Agricultural Experiment Station, Orono, Maine.

BONNS, W. W., 228 East 13th Street, Apartment 4, Indianapolis, Ind.

BORODIN, D. N., President, Russian Agricultural Agency in America, Room 309, 136 Liberty Street, New York, N. Y.

*BOURNE, BENJAMIN ARTHUR, Professor of Plant Pathology, College of Agriculture and Mechanic Arts, University of Porto Rico, Mayaguez, P. R.

BOYCE, JOHN SHAW, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 428 New Post Office Building, Portland, Ore.

BOYD, ORAN CECIL, Plant Pathologist, Georgia State Board of Entomology, Thomasville, Ga.

BOYLE, CONNELL, University College, Cork, Ireland.

BOYLE, LYTTON WESLEY, Industrial Research Fellow, Department of Plant Pathology, University of Wisconsin, Madison, Wis.

BRANDES, ELMER WALKER, Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

†BRANN, JOHN WILLIAM, Assistant Professor of Plant Pathology, University of Wisconsin, Horticultural Building, Madison, Wis.

BRANSTETTER, B. B., Department of Botany, University of Missouri, Columbia, Mo.

BRAUN, HARRY, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BRENTZEL, W. E., Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Agricultural College, N. D.

BRIERLEY, PHILIP, Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BRIERLEY, WILLIAM BROADHURST, Head of Department of Mycology, Institute of Plant Pathology, Rothamsted Experimental Station, Harpenden, Herts, England.

BRIGGS, FRED N., Assistant Pathologist, U. S. Department of Agriculture, 124 Hilgard Hall, University of California, Berkeley, Calif.

†BROOKS, CHARLES, Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BROWN, FLORENCE COERPER, 804 Indiana Avenue, Urbana, Ill.

BROWN, J. G., Department of Botany, University of Chicago, Chicago, Ill.

BROWN, MABEL MARY, Assistant Professor of Botany, University of New Hampshire, Durham, N. H.

BROWN, NELLIE ADALESA, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BRUNER, STEPHEN COLE, Chief, Department of Plant Pathology and Entomology, Estacion E. Agronomica, Santiago de las Vegas, Havana Province, Cuba.

BRYAN, MARY KATHERINE, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

BULLER, A. H. R., Professor of Botany, University of Manitoba, Winnipeg, Manitoba, Canada.

BURGER, O. F., Plant Pathologist, Agricultural Experiment Station, Gainesville, Fla.

*BURKHOLDER, WALTER H., Assistant Professor of Plant Pathology, Cornell University, Ithaca, N. Y.

BURNS, GEORGE PLUMER, Professor of Botany, University of Vermont, Botanist, Agricultural Experiment Station, 453 So. Willard Street, Burlington, Vt.

BUTLER, L. F., Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 139 N. Clark Street, Chicago, Ill.

BUTLER, ORMOND R., Professor of Botany, New Hampshire College of Agriculture, and Botanist, New Hampshire Agricultural Experiment Station, Durham, N. H.

BUTLER, WALLACE, Agent, Bureau of Plant Industry, U. S. Department of Agriculture, 315 Jennings Avenue, San Antonio, Texas.

†BYARS, LUTHER PARRIS, Marion, S. C.

CALDIS, PANOS DEMETRIUS, Research Assistant in Plant Pathology, University of California, 209 Agricultural Hall, Berkeley, Calif.

CALDWELL, J. S., Physiologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

CARDINELL, HORACE ALBERT, Extension Specialist, Michigan Agricultural College, East Lansing, Mich.

CARON, OMER, Botanist, Department of Agriculture, Quebec, Canada.

CARSNER, EUBANKS, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Citrus Experiment Station, Riverside, Calif.

CASH, LILLIAN C., Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 126 Tennessee Ave., N. E., Washington, D. C.

CHAPMAN, P. J., Instructor in Entomology, Cornell University, Roberts Hall, Ithaca, N. Y.

CHARLES, VERA KATHERINE, Associate Mycologist, Bureau of Plant Industry, U. S. Department of Agriculture, The Northumberland, Washington, D. C.

CHILDS, LEROY, Entomologist and Pathologist, Hood River Experiment Station, Hood River, Oreg.

CHIVERS, ARTHUR HOUSTON, Professor of Botany, Dartmouth College, Baleh Road, Hanover, N. H.

CHRISTENSEN, JONAS J., Assistant Pathologist, Agricultural College, University of Minnesota, University Farm, St. Paul, Minn.

*CHUPP, CHARLES DAVID, Assistant Professor of Plant Pathology, New York State College of Agriculture, Ithaca, N. Y.

CLAPP, GRACE LUCRETIA, Professor of Botany, Milwaukee-Downer College, Milwaukee, Wis.

CLARK, ELIZABETH STULTS, Fellow and Assistant in Plant Pathology, New Jersey State Experiment Station, New Brunswick, N. J.

CLAYTON, EDWARD EASTMAN, Associate in Research, New York Agricultural Experiment Station, Riverhead, Long Island, N. Y.

†CLINTON, GEORGE PERKINS, Botanist, Connecticut Agricultural Experiment Station, New Haven, Conn.

CLOKEY, IRA W., 1619 Fletcher Avenue, South Pasadena, Calif.

CLOUGH, M. J., Bowker Chemical Company, 40 West Street, New York, N. Y.

CLUM, HAROLD HAYDEN, College of Agriculture and Mechanic Arts, Mayaquez, Porto Rico.

COLBY, A. S., University of Illinois, Urbana, Ill.

COLE, JOHN RUFUS, Junior Pathologist, Field Station, Thomasville, Ga.

COLLEY, REGINALD HUNTER, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Old Soils Building, Madison, Wis.

COLLINS, JAMES FRANKLIN, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 13 Brown Street, Providence, R. I.

CONARD, HENRY S., Professor of Botany, Grinnell College, Grinnell, Iowa.

CONNERS, IBRA LOCKWOOD, Plant Pathologist, Dominion Department of Agriculture, Dominion Experimental Farm, Brandon, Manitoba, Canada.

†COOK, MELVILLE T., Plant Pathologist, Insular Experiment Station, Rio Piedras, Porto Rico.

COOLEY, JACQUELIN S., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*COONS, GEORGE HERBERT, Associate Professor of Botany, and Associate Botanist in charge Plant Pathology, Michigan Agricultural College, East Lansing, Mich.

COTNER, FRANK B., Assistant Professor, Montana State College, Bozeman, Mont.

COTTER, RALPH U., Junior Agronomist, Bureau of Plant Industry, U. S. Department of Agriculture, University Farm, St. Paul, Minn.

COUEY, WORTH G., Extension Pathologist, North Dakota Agricultural College, Agricultural College, N. Dak.

COWGILL, HORACE BRANSON, Agronomist, Bureau of Plant Industry, U. S. Department of Agriculture, 206 Federal Building, Fort Smith, Ark.

CRAIGIE, J. H., Plant Pathologist, Dominion Laboratory of Plant Pathology, Manitoba Agricultural College, Winnipeg, Canada.

CROCKER, WILLIAM, Director, Boyce Thompson Institute for Plant Research, Yonkers, N. Y.

CROWLEY, DANIEL J., Cranberry Laboratory, Longbeach, Wash.

CURRAN, GORDON C., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Illinois State Leader in Barberry Eradication, Box 72, Urbana, Ill.

DANA, BLISS F., Assistant Professor of Plant Pathology, State College of Washington, Pullman, Wash.

DASH, JOHN SYDNEY, Professor of Agriculture, Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies.

DAVIS, RAY J., Teacher in Biology, Ricks College, P. O. Box 125, Rexburg, Idaho.

DAVIS, WILLIAM HAROLD, Assistant Professor of Botany, Massachusetts Agricultural College, 12 Nutting Avenue, Amherst, Mass.

DAY, LEONARD H., Pomology Division, University Farm, Davis, Calif.

DEAN, HORACE S., Plant Quarantine Inspector, Federal Horticultural Board, U. S. Department of Agriculture, The Alabama, Apartment 607, Washington, D. C.

DEATHERAGE, JOHN R., Student Assistant in Botany, University of Tennessee, Morrill Hall, Knoxville, Tenn.

DEBRUYN, HELENA L. G., Botanist, Instituut voor Phytopatholgie, Hinkeloordsche Weg 5, Wageningen, Holland.

DEMEREC, M., Investigator, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, N. Y.

DEREKOWSKI, CHARLES W., Consulting Agricultural Expert, Importer and Grower of Sugar Beet Seed, Moffat Block, Detroit, Mich.

DERICKSON, SAMUEL HOFFMAN, Professor of Biology, Lebanon Valley College, 473 E. Main Street, Annville, Pa.

DETMERS, FREDA, Assistant Botanist, Ohio Agricultural Experiment Station, Wooster, Ohio.

DETWILER, SAMUEL BERTOLET, Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*DICKSON, BERTRAM THOMAS, Professor of Botany and Head of Department, Macdonald College, Macdonald College P. O., Quebec, Canada.

DICKSON, FRANK, Assistant Professor of Botany, University of British Columbia, Vancouver, B. C., Canada.

DIEHL, WILLIAM W., Assistant Mycologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

DIETZ, S. M., Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Ames, Iowa.

DOBBINS, RAYMOND A., Instructor in Botany, Ohio State University, Columbus, Ohio.

DODGE, BERNARD OGILVIE, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*DODGE, CARROLL WILLIAM, Assistant Professor of Botany, Curator of the Farlow Library, Harvard University, 20 Divinity Avenue, Cambridge 38, Mass.

DOOLITTLE, SEARS P., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University of Wisconsin, Madison, Wis.

DORAN, WILLIAM LEONARD, Assistant Research Professor of Botany, Massachusetts Agricultural College, Amherst, Mass.

DOSDALL, LOUISE, Mycologist, College of Agriculture, University of Minnesota, University Farm, St. Paul, Minn.

DRAYTON, FRANK LISLE, Plant Pathologist, Division of Botany, Dominion Department of Agriculture, Central Experimental Farm, Ottawa, Canada.

DRECHSLER, CHARLES, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

DUFRENOY, JEAN, Chef des Traveaux, Station de Pathologie Vegetale, 11 bis Rue d'Alesia, Paris, 14e, France.

DUGGAR, B. M., Professor of Plant Physiology, Washington University, Physiologist, Missouri Botanical Garden, St. Louis, Mo.

DUNEGAN, JOHN CLYMER, Junior Pathologist, U. S. Peach Disease Field Laboratory, Bureau of Plant Industry, U. S. Department of Agriculture, Fort Valley, Ga.

DUNGAN, GEORGE HARLAN, College of Agriculture, University of Illinois, Urbana, Ill.

DURRELL, L. W., Botanist and Plant Pathologist, Colorado Experiment Station, Fort Collins, Colo.

DUTTON, WALTER CURTIS, Research Associate in Horticulture, Michigan Agricultural College, East Lansing, Mich.

DYE, H. W., Peninsular Chemical Company, Orlando, Florida.

DYKSTRA, THEODORE P., Student, University of Wisconsin, Madison, Wis.

EARLE, FRANKLIN SUMNER, Director of Agriculture, General Sugar Company, Herradura, Cuba.

EASTHAM, JOHN WILLIAM, Provincial Plant Pathologist, Provincial Government of British Columbia, Court House, Vancouver, B. C., Canada.

ECCLES, ROBERT GIBSON, 681 Tenth Street, Brooklyn Borough, New York, N. Y.

†EDGERTON, CLAUDE WILBUR, Professor of Botany, Louisiana State University, Baton Rouge, La.

*EDSON, HOWARD AUSTIN, Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

EKVALL, LEONARD E., Laboratory Assistant, Northwestern University, 1329 Gregory Avenue, Wilmette, Ill.

ELLIOTT, CHARLOTTE, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ELMER, OTTO H., Assistant in Plant Pathology, Iowa State College, No. 3–4 Apt. House, Campus, Ames, Iowa.

ESSARY, SAMUEL HENRY, Botanist, Agricultural Experiment Station, University of Tennessee, Knoxville, Tenn.

EVANS, WALTER H., Chief of Insular Experiment Stations, U. S. Department of Agriculture, Washington, D. C.

EVANS, WILLIAM GEORGE, Demonstrator in Botany, Ontario Agricultural College, Guelph, Ontario, Canada.

EZEKIEL, WALTER N., Assistant Plant Pathologist, University of Maryland, Agricultural Experiment Station, College Park, Md.

FAIRMAN, CHARLES E., Lyndonville, N. Y.

FAJARDO, TRANQUILINO GANZON, Department of Plant Pathology, University of Wisconsin, Madison, Wis.

FANT, GORDON V., Extension Plant Pathologist, North Carolina State College, Raleigh, N. C.

FARIS, JAMES ABRAHAM, Pathologist, Tropical Plant Research Foundation, Harvard Laboratory, Central Soledad, Cienfuegos, Cuba.

FAULL, JOSEPH HORACE, Professor of Botany, University of Toronto, Toronto, Canada.

FAWCETT, EDNA HAGUE, Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

FAWCETT, GEORGE L., Estacion Experimentel Agricola, Tucuman, Argentina, S. A.

†FAWCETT, HOWARD SAMUEL, Professor of Plant Pathology, University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, Calif.

FELIX, EARL LOUIS, Fellow, Department of Plant Pathology, Cornell University, Ithaca, N. Y.

FELLOWS, HURLEY, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University of Wisconsin, 1821 University Avenue, Madison, Wis.

FENNELL, ROBERT EDWARD, Assistant Pathologist, Agricultural Experiment Station, Wooster, Ohio.

FENNER, L. M., South Carolina State Crop Pest Commission, Clemson College, S. C.

FERNOW, KARL WERMANN, Instructor, Department of Plant Pathology, New York State College of Agriculture, Ithaca, N. Y.

*FIELDS, WALTER SAMUEL, Associate Pathologist, Federal Horticultural Board, U. S. Department of Agriculture, Washington, D. C.

FILLER, EDMUND C., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 1 Paul Revere Road, Arlington Heights, Mass.

FISHER, DURWARD FREDERICK, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Wenatchee, Wash.

FITCH, HAROLD W., 1117 Hall St. S.E., Grand Rapids, Mich.

FITZPATRICK, HARRY MORTON, Professor of Plant Pathology, Cornell University, Ithaca, N. Y.

FLETCHER, DONALD G., Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 300 Lewis Building, Minneapolis, Minn.

FLOR, HAROLD H., University Farm, St. Paul, Minn.

FLYNN, JOHN E., Department of Plant Pathology, Cornell University, Ithaca, N. Y.

FOEX, ETIENNE, Directeur, Station de Pathologie Vegetale de Paris, 11 bis Rue d'Alesia, Paris, 14, France.

FOLSOM, DONALD, Plant Pathologist, Maine Agricultural Experiment Station, Orone, Maine.

FOSTER, A. C., Box 549, Sanford, Fla.

FRASER, WILLIAM POLLOCK, Pathologist, Dominion Laboratory of Plant Pathology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

†FREEMAN, EDWARD MONROE, Professor of Plant Pathology and Botany, Dean College of Agriculture, Forestry, and Home Economics, University of Minnesota, University Farm, St. Paul, Minn.

FREIBERG, GEORGE WILLIAM, Eitzen, Minn.

†FROMME, FRED DENTON, Professor of Plant Pathology, Virginia Polytechnic Institute, Plant Pathologist, Agricultural Experiment Station, Blacksburg, Va.

†FULTON, HARRY R., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

GAGNON, MOISE J., Graduate Student, Macdonald College, P. O. Box 37, Macdonald College P. O., Canada.

GAINES, EDWARD FRANKLIN, Associate Professor Farm Crops, Cerealist Experiment Station, State College of Washington, Pullman, Wash.

GALLOWAY, B. T., Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*GARDNER, MAX WILLIAM, Associate Botanist, Purdue University Agricultural Experiment Station, LaFayette, Ind.

GARDNER, WRIGHT AUSTIN, Head of Department of Botany, Alabama Polytechnic Institute, Auburn, Ala.

GARRETT, A. O., 791 Ninth Avenue, Salt Lake City, Utah.

GATES, PERCIVAL TAYLOR, Fellow, University of Chicago, Chicago, Ill.

GEORGE, DOROTH CHAUNCEY, State Plant Pathologist, Arizona Commission of Agriculture and Horticulture, Box 348, Phoenix, Ariz.

GIBSON, FREDERICK, Superior, Arizona.

†GIDDINGS, NAHUM JAMES, Professor of Plant Pathology, West Virginia University, Morgantown, W. Va.

GILBERT, ALFRED HOLLEY, Assistant Professor of Botany and Associate Pathologist, University of Vermont, and Plant Pathologist, Vermont Department of Agriculture, 191 Loomis Street, Burlington, Vt.

*GILBERT, EDWARD M., Professor of Botany and Plant Pathology, University of Wisconsin, Madison, Wis.

GILBERT, WILLIAM WILLIAMS, Plant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

GILL, LAKE S., Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, c/o U. S. Forest Service, Ferry Building, San Francisco, Calif.

†GILMAN, JOSEPH CHARLES, Associate Professor of Botany, Iowa State College, 518 Ash Avenue, Ames, Iowa.

GILMORE, GRACE, Laboratory Technician, Agricultural Experiment Station, Wooster, Ohio.

GILMORE, R. CLARK, Camden, Ohio.

GLOYER, WALTER O., Associate in Research Plant Pathology, New York Agricultural Experiment Station, Geneva, N. Y.

GODFREY, G. H., Plant Pathologist, Agricultural Department, The Bayer Company, 80 Varick Street, New York, N. Y.

GODKIN, JAMES, Extension Pathologist, Virginia Polytechnic Institute, Blacksburg, Va.

GODWIN, CLARENCE HURDMAN, Plant Disease Investigator, Dominion Government Plant Pathology Laboratory, Fredericton, N. B., Canada.

GOODING, J. HUNTER, Agriculturist, E. I. Du Pont De Nemours & Company, Inc., 8099 Du Pont Building, Wilmington, Del.

GORDON, WILLIAM LAURENCE, Post Graduate Student, Macdonald College, Macdonald College P. O., Quebec, Canada.

GORMAN, M. J., Lecturer in Agricultural Botany, College of Science, Upper Merrion Street, Dublin, Ireland.

GOSS, ROBERT WHITMORE, Associate Plant Pathologist, University of Nebraska, College of Agriculture, Lincoln, Nebr.

GRANOVSKY, ALEXANDER A., Instructor in Economic Entomology, University of Wisconsin, 1532 University Avenue, Madison, Wis.

GRATZ, LEVI OTTO, Assistant Plant Pathologist, Agricultural Experiment Station, Hastings Laboratory, Hastings, Fla.

GRAVATT, GEORGE FLIPPO, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

GRAVES, ARTHUR H., Curator of Public Instruction, Brooklyn Botanic Garden, Brooklyn, N. Y.

GREENE, WESLEY, 1216 Belle Avenue, Lakewood, Cleveland, Ohio.

GREGORY, CHARLES T., Associate in Botany, Purdue Agricultural Experiment Station, 1022 First Street, W. Lafayette, Ind.

GRIFFITHS, MARION ALICE, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

GROSSENBACHER, J. G., Apopka, Florida.

*GROVES, J. F., Professor of Botany, Ripon College, Ripon, Wis.

GUBA, EMIL FREDERICK, Assistant Research Professor of Botany, Market Garden Field Station, 240 Beaver St., Waltham, Mass.

GUSSOW, HANS THEODOR, Dominion Botanist, Department of Agriculture, Central Experimental Farm, Ottawa, Ontario, Canada.

HAENSELER, CONRAD MARTIN, Assistant Plant Pathologist, New Jersey State Experiment Station, New Brunswick, N. J.

HARPER, R. A., Professor of Botany, Columbia University, New York, N. Y.

HART, HELEN, Assistant Plant Pathologist, University of Minnesota, University Farm, St. Paul, Minn.

HARTER, LEONARD L., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

HARTGE, LENA A., 5241 University Way, Seattle, Wash.

†HARTLEY, CARL, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

HARVEY, RODNEY BEECHER, Associate Professor of Plant Physiology, University of Minnesota, University Farm, 2104 Scudder Street, St. Paul, Minn.

*HASKELL, ROYAL J., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

HAYMAKER, HERBERT HENLEY, Associate Professor, Kansas State Agricultural College, 315 N. 16th Street, Manhattan, Kansas.

HEALD, FREDERICK DEFOREST, Head of Department of Plant Pathology, State College of Washington, and Plant Pathologist, Agricultural Experiment Station, College Station, Pullman, Wash.

HEDGCOCK, GEORGE GRANT, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

HEDGES, FLORENCE, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

HEMMI, TAKEWO, Professor, Laboratory of Phytopathology, Biological Institute, Department of Agriculture, Kyoto Imperial University, Kyoto, Japan.

HENRY, ARTHUR WELLESLEY, Assistant Plant Pathologist, University of Minnesota, Agent, Bureau of Plant Industry, U. S. Department of Agriculture, University Farm, St. Paul, Minn.

†HESLER, LEXEMUEL RAY, Professor of Botany, University of Tennessee, Knoxville, Tenn.

*HIGGINS, BASCOMBE BRITT, Botanist, Georgia Agricultural Experiment Station, Experiment, Ga.

HILL, H., Student, Macdonald College, Macdonald College P. O., Quebec, Canada.

HITE, BERTHA COURTRIGHT, Assistant Botanist, Department of Agriculture, Branch Seed Laboratory, Corvallis, Oregon.

HO, WILLIAM T. H., National University of Kwangtung, Canton, China.

HOCKEY, JOHN FREDERICK, Plant Pathologist, Field Laboratory of Plant Pathology, Dominion Department of Agriculture, Kentville, Nova Scotia, Canada.

HOFFER, GEORGE N., Pathologist, U. S. Department of Agriculture, and Associate Botanist, Purdue University Agricultural Experiment Station, 434 Littleton Street, W. Lafayette, Ind.

HOLBERT, J. R., Agronomist, Office of Cereal Investigations, U. S. Department of Agriculture.

HOLMES, FRANCIS OLIVER, Protozoologist, Boyce Thompson Institute for Plant Research, 1086 N. Broadway, Yonkers, N. Y.

HONEY, EDWIN EARL, Department of Plant Pathology, Washington State College of Agriculture, Pullman, Wash.

HOPKINS, EDWIN FRASER, National Research Council Fellow, Cornell University, 104 Harvard Place, Ithaca, N. Y.

†HORNE, WILLIAM TITUS, Associate Professor of Plant Pathology, University of California, 209 Agr. Hall, Berkeley, Calif.

HOTSON, J. W., Assistant Professor of Botany, University of Washington, Seattle, Wash.

HOWARD, GRACE ELIZABETH, Seattle Title Trust Co., Seattle, Wash.

HOWARD, NATHANIEL ORSON, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Brown University, Providence, R. I.

HOWITT, J. E., Professor of Botany, Ontario Agricultural College, Guelph, Ontario, Canada.

HUBER, GLENN A., Student, Washington State College, 610 Linden Street, Pullman, Wash.

HUBER, HARVEY EVERT, Dean of College of Liberal Arts and Professor of Biology, Ohio Northern University, Ada, Ohio.

HUBERT, ERNEST EVERETT, School of Forestry, University of Idaho, Moscow, Idaho.

HUMPHREY, CLARENCE JOHN, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 1714 Adams Street, Madison, Wis.

†HUMPHREY, HARRY BAKER, Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

HUMPHREY, SYLVESTER S., Instructor in Botany, Ohio State University, Columbus, Ohio.

HUNGERFORD, CHARLES WILLIAM, Professor of Plant Pathology, University of Idaho, Pathologist, Agricultural Experiment Station, Moscow, Idaho.

HUNT, N. REX, Associate Pathologist, Federal Horticultural Board, U. S. Department of Agriculture, Washington, D. C.

HUNT, WILLIS R., Graduate Student, Yale University, and Assistant in Botany, Agricultural Experiment Station, New Haven, Conn.

HUNTER, HERMAN A., Assistant Extension Pathologist, University of Maryland, College Park, Md.

HURSH, C. R., Assistant Plant Pathologist, Agricultural Experiment Station, University Farm, St. Paul, Minn.

HURST, R. R., Assistant Pathologist, Dominion Laboratory of Plant Pathology, Charlottetown, P. E. I., Canada.

HURT, ROBERT HARRY, Assistant Plant Pathologist, Virginia Experiment Station, Crozet, Va.

*HUTCHINS, LEE M., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, U. S. Peach Disease Field Laboratory, Fort Valley, Georgia.

HUTTON, LYNN D., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

HYNES, H. J., Biological Branch, Department of Agriculture, Sydney, Australia.

†JACKSON, HERBERT SPENCER, Botanist, Purdue University Agricultural Experiment Station, West Lafayette, Ind.

†JAGGER, IVAN C., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*JEHLE, ROBERT ANDREW, Specialist in Plant Pathology, University of Maryland, College Park, Md.

JENKINS, ANNA ELIZA, Assistant Mycologist, Bureau of Plant Industry, U. S. Department of Agriculture, Southbrook Courts, Washington, D. C.

JENNISON, HARRY MILLIKEN, Professor of Botany, University of Tennessee, Morrill Hall, Knoxville, Tenn.

JENSEN, C. N., State Superintendent of Education, Salt Lake City, Utah.

JOHANN, HELEN, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University of Wisconsin, Horticultural Building, Madison, Wis.

†JOHNSON, AARON GUY, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

JOHNSON, EDWARD CARL, Dean, College of Agriculture, and Director, Agricultural Experiment Station, Pullman, Wash.

JOHNSON, HOWARD WILFRED, University Scholar, Ohio State University, Botany Department, Columbus, Ohio.

JOHNSON, JAMES, Professor of Horticulture, University of Wisconsin, Agent, U. S. Department of Agriculture, Horticultural Building, Madison, Wis.

JOHNSTON, CHARLES OTIS, Assistant Pathologist, Kansas State Agricultural College, Manhattan, Kansas.

JOHNSTON, JOHN ROBERT, Director of Agricultural Research Department, United Fruit Company, 492 Centre St., Jamaica Plain, Mass.

†JONES, FRED REUEL, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University of Wisconsin, Madison, Wis.

JONES, LEON KILBY, Instructor in Plant Pathology, University of Wisconsin, Madison, Wis.

†JONES, LEWIS RALPH, Professor of Plant Pathology, University of Wisconsin, 146 Prospect Avenue, Madison, Wis.

JORSTAD, IVAR, Statsmykolog, Botanisk Museum, Oslo, Norway.

KANOUSE, BESSIE B., 1236 Prospect Street, Ann Arbor, Mich.

KAUFFMAN, C. H., Professor of Botany and Director of University Herbarium, University of Michigan, 1236 Prospect Street, Ann Arbor, Mich.

†KEITT, GEORGE WANNAMAKER, Professor of Plant Pathology, University of Wisconsin, 803 State Street, Madison, Wis.

KELLEY, JOHN GRADY, Laboratory Assistant in Plant Pathology, University of Florida, Agricultural Experiment Station, P. O. Box 182, Quincy, Fla.

KEMPTON, FORREST ELLWOOD, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

KENDRICK, JAMES B., Assistant Botanist, Purdue Agricultural Experiment Station, LaFayette, Ind.

†KERN, FRANK DUNN, Head, Department of Botany, Pennsylvania State College, State College, Pa.

KHAZANOFF, AMRAM, In Charge of Experimental Agriculture, Palestine Jewish Colonization Association, Haifa, Palestine.

KIENHOLZ, AARON RAYMOND, Instructor in Botany, University of Illinois, Urbana, Ill.

*KIRBY, ROBERT STEARNS, Assistant Professor of Plant Pathology Extension, Pennsylvania State College, State College, Pa.

KOEHLER, BENJAMIN, Associate in Crop Pathology, University of Illinois, Old Agricultural Building, Urbana, Ill.

KOHL, E. J., Instructor in Botany, Purdue University, LaFayette, Ind.

KOLK, LAURA A., Research Assistant, Brooklyn Botanic Garden, Washington Avenue, Brooklyn, N. Y.

KOTILA, JOHN ERNEST, Research Assistant in Plant Pathology, Michigan Agricultural College, East Lansing, Mich.

KROUSE, D. H., Senior in Plant Pathology, Cornell University, Ithaca, N. Y.

KROUT, W. S., Extension Specialist, Pennsylvania State College, State College, Pa.

KUNKEL, L. O., Plant Pathologist, Thompson Institute for Plant Research, Yonkers, N. Y.

KUNTZ, WILLIAM A., Instructor in Botany, Pennsylvania State College, State College, Pa.

LACHAINE, O. W., Macdonald College, Macdonald College P. O., Quebec, Canada.

LACKEY, CHARLES FRANKLIN, Junior Pathologist, Citrus Experiment Station, Riverside, Calif.

LAMBERT, EDMUND BRYAN, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University Farm, St. Paul, Minn.

LAMKEY, ERNEST M. R., Agricultural Experiment Station, Newark, Del.

LANTZ, CYRUS W., Professor of Botany, Iowa State Teachers College, 1518 Washington Street, Cedar Falls, Iowa.

LARUE, CARL D., Assistant Professor of Botany, University of Michigan, Ann Arbor, Mich.

LAURITZEN, JOHN I., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

LEACH, JULIAN GILBERT, Assistant Professor in Plant Pathology and Botany, University of Minnesota, University Farm, St. Paul, Minn.

LECLERG, E. L., Botany Department, Iowa State College, Ames, Iowa.

*LEE, HENRY ATHERTON, Pathologist, Experiment Station, Hawaiian Sugar Planters' Association, Honolulu, Hawaii.

LEHENBAUER, P. A., Horticulturist, College of Agriculture, University of Nevada, Reno, Nev.

LEHMAN, SAMUEL GEORGE, Associate Plant Pathologist, North Carolina Agricultural Experiment Station and North Carolina State College, State College Station, Raleigh, N. C.

*LEONIAN, LEON H., Assistant Professor of Plant Pathology and Assistant Plant Pathologist, West Virginia University, Morgantown, W. Va.

LEUKEL, ROBERT WHITMER, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

LEVINE, MICHAEL, Biologist, Cancer Division, Montefiore Hospital, 1646 University Avenue, New York, N. Y.

LEVINE, MOSES N., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University Farm, St. Paul, Minn.

LEWIS, ISAAC M., Professor of Botany, University of Texas, Austin, Texas.

LINFORD, MAURICE BLOOD, Student, Department of Plant Pathology, University of Wisconsin, Madison, Wis.

LINK, GEORGE K. K., Associate Professor of Plant Pathology, University of Chicago, Chicago, Ill.

LUCKIE, JOHN M., Botanist, University of Sydney Botany School, Sydney, Australia.

LUDWIG, CLINTON ALBERT, Associate Botanist and Plant Pathologist, South Carolina Agricultural Experiment Station, Clemson College, S. C.

LUNGREN, ERNEST ALFRED, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Fort Collins, Colo.

†LUTMAN, BENJ. F., Professor of Plant Pathology, University of Vermont, and Plant Pathologist, Agricultural Experiment Station, 111 North Prospect Street, Burlington, Vt.

*LYMAN, GEORGE RICHARD, Dean, College of Agriculture, University of West Virginia, Morgantown, W. Va.

McCALLAN, S. E. ALAN, Assistant and Graduate Student, New York State College of Agriculture, Ithaca, N. Y.

McCALLUM, ALAN WILFRID, Forest Pathologist, Central Experimental Farm, Department of Agriculture, Ottawa, Canada.

MACCLEMENT, W. T., Professor of Biology, Queens University, Kingston, Ontario, Canada.

McCLINTOCK, JAMES ALBERTINE, Horticulturist and Associate Pathologist, University of Tennessee Experiment Station, 303 Morrill Hall, Knoxville, Tenn.

McCORMICK, FLORENCE ANNA, Pathologist, Connecticut Agricultural Experiment Station, New Haven, Conn.

*McCUBBIN, WALTER ALEX., Chief Plant Pathologist, Pennsylvania Bureau of Plant Industry, Harrisburg, Pa.

*McCULLOCH, LUCIA, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

McFARLAND, FRANK T., Professor of Botany, University of Kentucky, Lexington, Ky.

MACINNES, FRANCES JEAN, Instructor in Biology, Newcomb College, 1305 Pine Street, New Orleans, La.

McKAY, MARION BERTICE, Plant Pathologist, Oregon Agricultural Experiment Station, Corvallis, Oregon.

McKINNEY, HAROLD HALL, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University of Wisconsin, Madison, Wis.

McLARTY, HAROLD ROSS, Pathologist, Field Laboratory of Plant Pathology, Department of Agriculture of Ottawa, Summerland, B. C., Canada.

MACLEOD, DONALD J., Plant Pathologist, Box 867, Fredericton, N. B., Canada.

†MACMILLAN, HOWARD GOVE, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Greeley, Colo.

McMURPHY, JAMES, Assistant Professor of Botany, Stanford University, Stanford University, Calif.

McWHORTER, FRANK PADEN, Plant Pathologist, Virginia Truck Experiment Station, Norfolk, Va.

MACKAY, ALEXANDER HOWARD, Superintendent of Education for Province of Nova Scotia, 61 Queen Street, Dartmouth, Nova Scotia, Canada.

MACKIE, WM. W., Assistant Professor, College of Agriculture, University of California, 124 Hilgard Hall, Berkeley, Calif.

MAINS, E. B., Associate Botanist, Purdue University Agricultural Experiment Station, Lafayette, Ind.

MAJOR, THOMAS GRANT, Tobacco Specialist, Department of Agriculture—Canada, Tobacco Division, Central Experimental Farm, Ottawa, Ont., Canada.

MANEVAL, WILLIS EDGAR, Assistant Professor of Botany, University of Missouri, 305 Hicks Avenue, Columbia, Mo.

†MANNS, THOMAS FRANKLIN, Plant Patnologist and Soil Bacteriologist, University of Delaware, Newark, Del.

MARDFIN, EMILE, 580 Van Cortlandt Park Avenue, Yonkers, N. Y.

MARSHALL, RUSH P., Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

MARTIN, GEORGE W., Professor of Biology and Curator of the Museum, Washington and Jefferson College, 49 South College Street, Washington, Pa.

MARTIN, GEORGE WILLARD, Assistant Professor of Botany, University of Iowa, Iowa City, Iowa.

*MARTIN, G. HAMILTON, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

MARTIN, JOSEPH P., Assistant Pathologist, Hawaiian Sugar Planters' Association, Honolulu, Hawaii.

*MARTIN, WILLIAM HOPE, Plant Pathologist, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

MASSAR, IVAN E., Student, Ohio State University, 1964 N. High Street, Columbus, Ohio.

MASSEY, A. B., Associate Professor, Virginia Polytechnic Institute, and Associate Bacteriologist and Plant Pathologist, Agricultural Experiment Station, Blacksburg, Va.

†MASSEY, LOUIS M., Professor of Plant Pathology, New York State College of Agriculture, Cornell University, Ithaca, N. Y.

MATSUMOTO, TAKASHI, Imperial College of Agriculture and Forestry, Morioka, Japan.

MATZ, JULIUS, In Charge of Agricultural Research, Guanica and Aguirre Centrals, Fortuna, Porto Rico.

MAY, CURTIS, Graduate Assistant in Botany, Ohio State University, State University, Columbus, Ohio.

MECKSTROTH, GUSTAV ADOLPH, Horticulture Department, University of Illinois, Urbana, Ill.

*MEIER, FRED C., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

MEINICKE, EMILIO PEPE M., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, c/o Forest Service, Ferry Building, San Francisco, Calif.

MELANDER, LEONARD WILLIAM, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, State Leader of Barberry Eradication, University of Minnesota, Department of Agriculture, University Farm, St. Paul, Minn.

MELCHERS, LEO EDWARD, Professor and Head Department of Botany and Plant Pathology, Kansas State Agricultural College, Manhattan, Kansas.

*MELHUS, I. E., Professor of Plant Pathology, Iowa State College, Ames, Iowa.

†METCALF, HAVEN, Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*MILES, LEE ELLIS, Extension Pathologist, Alabama Agricultural Experiment Station, Auburn, Ala.

MILLER, JOHN W., Department of Botany, Pennsylvania State College, State College, Pa.

MILLER, PIERRE A., Department of Botany & Plant Pathology, Kansas State Agricultural College, Manhattan, Kansas.

†MIX, ARTHUR JACKSON, Professor of Botany, University of Kansas, Lawrence, Kansas.

MIYABE, KINGO, Botanical Institute, College of Agriculture, Sapporo, Japan.

MOLLOY, JAMES MATHEW, Special Field Agent, Department of Entomology, 185 Boulevard North Highlands, Macon, Ga.

MONTEITH, JOHN JR., Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, University of Wisconsin, Horticulture Building, Madison, Wis.

†MOORE, GEORGE THOMAS, Director, Missouri Botanical Garden, Professor, Washington University, St. Louis, Mo.

MOORE, H. C., Extension Specialist, Michigan Agricultural College, East Lansing, Mich.

MOORE, WILLIAM DEWEY, Extension Pathologist, Clemson Agricultural College, Clemson College, S. C.

MORRIS, HARRY ELWOOD, Associate Professor in Botany and Bacteriology, Montana Experiment Station, Bozeman, Mont.

MORSE, W. H., Box 52, Santa Barbara, Calif.

†MORSE, WARNER J., Director, Maine Agricultural Experiment Station, Orono, Maine.

MOSS, EZRA HENRY, Department of Botany, University of Alberta, Edmonton, Alberta, Canada.

MULLER, ALBERT STANLEY, Research Assistant, Cornell University, Ithaca, N. Y.

MUNCIE, JESSE HOWARD, Special Research Assistant, Crop Protection Institute, Iowa State College, Ames, Iowa.

MUNN, MANCEL THORNTON, Associate in Research, New York State Agricultural Experiment Station, Geneva, N. Y.

MURPHY, PAUL A., Head of Plant Disease Division, Department of Lands and Agriculture, College of Science, Upper Merrion Street, Dublin, Ireland.

NAKATA, K., Professor of Plant Pathology, Department of Agriculture, Kyushu Imperial University, Fukuoka, Japan.

NEAL, DAVID CARLETON, Plant Pathologist, Mississippi Experiment Station and State Plant Board, Box 95, A. & M. College, Miss.

NELSON, RALPH MELVIN, Instructor in Forest Pathology, University of Minnesota, 2089 Carter Avenue, St. Paul, Minn.

NELSON, RAY, Assistant in Plant Pathology, Agricultural Experiment Station, East Lansing, Mich.

NEWHALL, ALLAN GOODRICH, Assistant Plant Pathologist, Agricultural Experiment Station, Wooster, Ohio.

NEWTON, MARGARET, Department of Biology, Saskatchewan University, Saskatoon, Sask., Canada.

NICOLAIDES, G. I., 6 Highland Street, Oneonta, N. Y.

*NINMAN, HERMAN J., Assistant Plant Pathologist, State Department of Agriculture, State Capitol Annex, Madison, Wis.

NISHIDA, TOJI, Plant Pathologist, Kyu-shu Laboratory, Imperial Agricultural Experiment Station, Kumamoto, Japan.

NISIKADO, Y., Plant Pathologist, Ohara Agricultural Institute, Kurashiki, Okayama, Japan.

NIXON, WALTER HALL, Superintendent of Trial Grounds, C. C. Morse & Company, San Carlos, Calif.

NOBLE, ROBERT JACKSON, Principal Assistant Biologist, Department of Agriculture, George Street North, Sydney, New South Wales, Australia.

NOLLA, J. A. B., Assistant Plant Pathologist, Insular Experiment Station, Rio Piedras, Porto Rico.

NORTON, JOHN B. S., Professor of Systematic Botany and Mycology, University of Maryland, and Botanist and Plant Pathologist, Experiment Station, College Park, Md.

OCFEMIA, GERARDO OFFIMARIA, Assistant Professor in Plant Pathology, University of the Philippines, Los Banos College, Laguna, P. I.

O'DONNELL, FRANK GETCHALL, Plant Quarantine Inspector, Federal Horticultural Board, U. S. Department of Agriculture, Washington, D. C.

†O'GARA, PATRICK JOSEPH, Director, Department of Agriculture, and Smelter By-Products Investigations, American Smelting & Refining Company, 700 McCornick Building, Salt Lake City, Utah.

OGILVIE, LAWRENCE, Government Plant Pathologist, Agricultural Station, Paget East, Bermuda.

†OLIVE, EDGAR W., 904 Hume-Mansur Building, Indianapolis, Ind.

†ORTON, CLAYTON ROBERTS, Professor of Plant Pathology, Pennsylvania State College, and Plant Pathologist, Agricultural Experiment Station, State College, Pa.

†ORTON, WILLIAM ALLEN, Scientific Director and General Manager, Tropical Plant Research Foundation, 1350 B Street, N. W., Washington, D. C.

*OSMUN, ALBERT VINCENT, Professor of Botany, Massachusetts Agricultural College, and Head of Department of Botany, Agricultural Experiment Station, Amherst, Mass.

OSTROM, EMIL HELMER, Agent, Bureau of Plant Industry, U. S. Department of Agriculture, University Farm, St. Paul, Minn.

OVERHOLTS, L. O., Associate Professor of Botany, Pennsylvania State College, State College, Pa.

OWENS, C. E., Associate Professor of Botany & Plant Pathology, Oregon Agricultural College, Corvallis, Oregon.

PAINTIN, RUTH DAVIS, Assistant in Botany, Northwestern University, 7719 N. Hermitage Avenue, Apt. G-2, Chicago, Ill.

PALMER, C. MERVIN, Instructor of Botany, Pennsylvania State College, State College, Pa.

PALMER, MARTIN, Instructor in Botany, Alabama Polytechnic Institute, Auburn, Ala.

PAMMEL, L. H., Professor of Botany, Iowa State College, and Botanist of the Agricultural Experiment Station, Ames, Iowa.

PANTANELLI, ENRICO, Director, Stazione Agraria Sperimentale, Bari, Italy.

PARKER, CHARLES S., 321 11th Street, N. E., Washington, D. C.

†PATTERSON, FLORA WAMBAUGH, 1215 Ocean Avenue, Brooklyn, N. Y.

†PEIRCE, HAROLD, 222 Drexel Building, Philadelphia, Pa.

PELTIER, GEORGE LEO, Professor of Plant Pathology, University of Nebraska, and Plant Pathologist, Agricultural Experiment Station, Lincoln, Nebr.

†PENNINGTON, LEIGH H., Professor of Forest Pathology, New York State College of Forestry, Syracuse, N. Y.

PEPPIN, SYDNEY GEORGE, District Inspector, Dominion Department of Agriculture, Charlottetown, Prince Edward Island, Canada.

PERRY, F. R., Burt, N. Y.

*PETRY, EDWARD J., 625 12th Avenue, Brookings, S. Dak.

PHILLIPS, EDITH HENRIETTA, 1311 Grove Street, Berkeley, Calif.

PIERCE, FRANCIS LESLIE, Senior Scientific Aid, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

PIERCE, ROY GIFFORD, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

PIERSTORFF, A. L., Department of Plant Pathology, New York College of Agriculture, Ithaca, N. Y.

PLAKIDAS, ANTONIOS GEORGE, Research Assistant, University of California, 209 Agricultural Hall, Berkeley, Calif.

PLATZ, GUSTAV A., Science Instructor, Graceland College, Lamoni, Iowa.

PLUNKETT, ORDA ALLEN, Assistant Professor of Botany, Illinois State Normal University, Normal, Ill.

POE, SAM, Student, University of Arkansas, 924 W. Maple Street, Fayetteville, Ark.

POOLE, ROBERT FRANKLIN, Associate Plant Pathologist, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

POOL, RAYMOND JOHN, Professor of Botany, University of Nebraska, Station A, Lincoln, Nebr.

PORCH, MADISON B., H. J. Heinz Company, Pittsburgh, Pa.

PORTER, CHARLES LYMAN, Assistant Professor of Plant Pathology, Purdue University, 484 Northwestern Avenue, West Lafayette, Ind.

PORTER, DONALD ROCKWELL, Department of Botany, Kansas Agricultural College, Manhattan, Kansas.

PORTER, R. HOWARD, Plant Pathologist, University of Nanking, Nanking, China.

PORTE, WILLIAM S., Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*POVAH, ALFRED HUBERT, Assistant Professor of Botany, Northwestern University, 9 Fisk Hall, Evanston, Ill.

PRITCHARD, F. J., Associate Physiologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

PURDY, HELEN ALICE, Department of Pathology, Boyce Thompson Institute for Plant Research, Croton-on-Hudson, N. Y.

QUANJER, HENDRIK MARIUS, Professor, University of Agriculture, and Director of the Laboratory for Plant Pathology and Potato Research, Instituut voor Phytopathology, Wageningen, Holland.

QUIRK, AGNES, Senior Scientific Aid, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

RACICOT, HOMER NOE, Plant Pathologist, Dominion of Canada Department of Agriculture, Laboratory of Plant Pathology, Ste. Anne de la Pocatiere, Quebec, Canada.

RAEDER, JOHN MILFORD, Assistant Plant Pathologist, Idaho Experiment Station, Moscow, Idaho.

RALEIGH, WALTER P., Research Fellow, Iowa Agricultural Experiment Station, Ames, Iowa.

RAMSEY, GLEN BLAINE, Homewood, Ill.

RAND, FREDERICK V., Associate Editor in Chief, Botanical Abstracts; Lecturer in Bacteriology, Johns Hopkins University, National Research Council, Washington, D. C.

RANDS, ROBERT DELAFIELD, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*RANKIN, WILLIAM HOWARD, Associate in Plant Pathology, New York State Agricultural Experiment Station, Geneva, N. Y.

†REDDICK, DONALD, Professor, Cornell University, Ithaca, N. Y.

REDDY, CHARLES S., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 615 Park Avenue, Lyon Park, Va.

REDDY, WALTER F., Associate Pathologist, Michigan Agricultural College, Botany Building, East Lansing, Mich.

REED, G. B., 218 Albert Street, Kingston, Ontario, Canada.

†REED, GEORGE MATTHEW, Curator of Plant Pathology, Brooklyn Botanic Garden, Brooklyn, N. Y.

REED, HOWARD SPRAGUE, Professor of Plant Physiology, Citrus Experiment Station, Riverside, Calif.

REID, P. E., Assistant in Botany and Graduate Student, University of Illinois, 209 Natural History Building, Urbana, Ill.

REIMER, F. C., Superintendent, Southern Oregon Branch Station, Talent, Oregon.

REINKING, OTTO AUGUST, Pathologist, United Fruit Company, Agricultural Research Department, 131 State Street, Boston, Mass.

REX, EDGAR GEORGE, Graduate Assistant in Plant Pathology, Pennsylvania State College, Botany Building, State College, Pa.

REYNOLDS, ERNEST SHAW, Professor of Botany and Plant Physiology, North Dakota Agricultural College, Agricultural College, N. Dak.

RHOADS, ARTHUR STEVENS, Assistant Plant Pathologist, Florida Agricultural Experiment Station, Citrus Blight Laboratory, Cocoa, Florida.

RICHARDS, BERT LORIN, Professor of Botany and Plant Pathology, Agricultural College of Utah, Logan, Utah.

RICHARDS, C. AUDREY, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 417 Sterling Place, Madison, Wis.

RICHARDSON, JAMES KEITH, Assistant Plant Pathologist, Laboratory of Plant Pathology, Box 867, Fredericton, N. B., Canada.

RIKER, ALBERT JOYCE, Instructor in Plant Pathology, University of Wisconsin, Madison, Wis.

ROBERTS, EDITH A., Associate Professor of Botany, Vassar College, Poughkeepsie, N. Y.

ROBERTS, JOHN WILLIAM, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ROBINSON, T. RALPH, Physiologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

RODENHISER, HERMAN A., Assistant in Plant Pathology, Agricultural Experiment Station, University Farm, St. Paul, Minn.

ROLFS, F. M., Botanist and Plant Pathologist, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

ROLFS, PETER HENRY, Director, Escola Superior de Agricultura e Veterinaria, Vicosa, Minas Geraes, Brazil, South America.

*RORER, JAMES BIRCH, Casilla de Correo "X," Guayaquil, Ecuador, South America.

ROSE, DEAN HUMBOLDT, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ROSE, JESSIE PERKINS, 77 6th St., Ashland, Oreg.

ROSE, R. C., Extension Pathologist, University of Minnesota, University Farm, St. Paul, Minn.

ROSEN, HARRY ROBERT, Associate Professor of Plant Pathology, University of Arkansas, Fayetteville, Ark.

*ROSENBAUM, JOSEPH, Head, Department of Botany and Biology, The Milford School, Milford, Conn.

ROSENFELD, ARTHUR HINTON, Special Technologist, Insular Experiment Station, Rio Piedras, Porto Rico.

RUDOLPH, BERT A., 36 E. San Antone, San Jose, Calif.

RUMBOLD, CAROLINE THOMAS, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Old Soils Building, Madison, Wis.

SAMSON, R. W., Student Assistant in Plant Pathology, College of Agriculture, Lincoln, Nebr.

SANDS, DAVID RICHMOND, Lecturer, Department of Botany, Ontario Agricultural College, Guelph, Ontario, Canada.

SANDS, HAROLD COLLENDER, Pathologist, Maine Potato Growers' Exchange, Spaulding, Maine.

SANFORD, G. B., University Farm, St. Paul, Minn.

SCHERER, CHRISTOPHER M., Principal, The Davey Institute of Tree Surgery, Kent, Ohio.

SCHLATTER, FIDEL PAUL, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

†SCHMITZ, HENRY, Professor of Forest Products, University of Idaho, Moscow, Idaho.

SCHNEIDERHAN, FELIX JOHN, Assistant Pathologist, Virginia Experiment Station, Blacksburg, Va.

SCHROEDER, H. J., JR., Saugerties, N. Y.

SCHULTZ, EUGENE S., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

†SCHWARZE, CARL ALOIS, Teacher of Science, Jamaica High School, 8610 85th Road, Woodhaven, N. Y.

SCOTT, GORDON A., Division of Botany, University of Saskatchewan, Saskatoon, Sask., Canada.

†SCOTT, WILLIAM MOORE, Division Manager, American Fruit Growers Inc., Sanford, Florida.

SEAL, J. L., Assistant Plant Pathologist, Florida Agricultural Experiment Station, Miami, Florida.

SEYMOUR, ARTHUR BLISS, Assistant in Farlow Herbarium, Harvard University, 20 Divinity Avenue, Cambridge 38, Mass.

SHAPOVALOV, MICHAEL, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Citrus Experiment Station, Riverside, Calif.

SHAW, HARRY B., Pathologist, Federal Horticultural Board, U. S. Department of Agriculture, 305 Custom House, New York, N. Y.

†SHEAR, CORNELIUS LOTT, Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*SHEAR, ELMER VANDERZEE, JR., Associate in Research, New York Agricultural Experiment Station, Vassar College Substation, Poughkeepsie, N. Y.

SHELDON, JOHN LEWIS, 308 Grandview Avenue, Morgantown, W. Va.

SHEPHERD, EDWARD FREDERICK SISNETT, Botanist and Mycologist, Department of Agriculture, Rednit, Mauritius.

SHERBAKOFF, C. D., Plant Pathologist, Agricultural Experiment Station, Knoxville, Tenn.

SHERWOOD, EVERETT CLIFTON, Extension Pathologist and Assistant Pathologist, West Virginia University, Morgantown, W. Va.

SHIRAI, DR., College of Agriculture, University of Tokyo, Komaba, Tokyo, Japan.

SIDERIS, CHRISTO PLUTARCHOS, Plant Pathologist, University of Hawaii and Hawaiian Pineapple Experiment Station, Honolulu, Hawaii.

SIEGLER, E. A., Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

SIGGERS, PAUL VICTOR, Plant Pathologist, United Fruit Company, Port Lincoln, Costa Rica.

SINDEN, JAMES, Department of Plant Pathology, Cornell University, Ithaca, N. Y.

SLAGG, CHARLES MERVYN, Chief, Tobacco Division, Dominion Department of Agriculture, Ottawa, Canada.

*SMITH, ERWIN F., Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

SMITH, GEORGE HUME, Instructor, University of Illinois, 308 Natural History Building, Urbana, Ill.

SMITH, MARION A., Graduate Student, Iowa State College, 2226 Donald Street, Ames, Iowa.

SMITH, RALPH ELIOT, Professor of Plant Pathology, University of California, 210 Agr. Hall, Berkeley, Calif.

SNELL, WALTER H., Assistant Professor of Botany, Brown University, Providence, R. I.

SOLHEIM, W. G., Assistant in Botany, University of Illinois, 209 Natural History Building, Urbana, Ill.

†SPAULDING, PERLEY, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

SPENCER, EDWIN ROLLIN, Professor of Biology, State Teachers College, Cape Girardeau, Mo.

SPIEGELBERG, CARL HENRY, Assistant in Plant Pathology, Washington State College, Box 665, College Station, Pullman, Wash.

SPRAGUE, RODERICK, 618 Realty Building, Spokane, Wash.

STADLER, L. J., Bussey Institution, Forest Hills, Boston, Mass.

STAHL, HORATIO S., Associate Professor of Biology, Virginia Polytechnic Institute, Blacksburg, Va.

†STAKMAN, E. C., Professor of Plant Pathology, College of Agriculture, and Plant Pathologist, Agricultural Experiment Station, University of Minnesota, University Farm, St. Paul, Minn.

†STEVENS, F. L., Professor of Plant Pathology, University of Illinois, Urbana, Ill.

STEVENS, HAROLD EDWIN, Plant Pathologist and Entomologist, Stripes Citrus Packing Company, P. O. Box 596, Ft. Myers, Florida.

STEVENS, NEIL EVERETT, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

STEVENSON, JOHN A., Chief Pathological Inspector, Federal Horticultural Board, 4113 Emery Place, N. W., Washington, D. C.

STEWART, DEWEY, U. S. Department of Agriculture, Rocky Ford, Colo.

†STEWART, FRED CARLTON, Chief of Research (Botany), New York Agricultural Experiment Station, Geneva, N. Y.

STILLINGER, CHARLES ROY, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 618 Realty Building, Spokane, Wash.

†STONE, ROLAND ELISHA, Associate Professor in Botany, Ontario Agricultural College, Guelph, Ontario, Canada.

†STOVER, WILMER GARFIELD, Professor of Botany, Ohio State University, Columbus, Ohio.

STRATTON, ROBERT, Assistant Professor of Botany and Plant Pathology, Oklahoma Agricultural and Mechanical College, 520 Hester Street, Stillwater, Okla.

STREETS, RUBERT BURLEY, Assistant Professor of Plant Pathology, University of Arizona, Tucson, Ariz.

STRONG, FORREST, Graduate Student, Michigan Agricultural College, East Lansing, Mich.

STUDHALTER, R. A., Department of Biology, Sul Ross Normal College, Alpine, Texas.

STURM, EDNA L., 235 First Street, N. E., Washington, D. C.

SUTTON, FREDERICK JAMES, Horticulturist, Niagara Sprayer Company, Middleport, N. Y.

SWARTZ, DELBERT, Assistant in Botany, Michigan Agricultural College, Box 556, East Lansing, Mich.

*SWINGLE, DEAN B., Head of Department of Botany and Bacteriology, Montana State College of Agriculture, Bozeman, Mont.

TANAKA, TYOZABURO, In Charge, Horticultural Institute; Librarian, Department of

Agriculture, Kyushu Imperial University, Engeigaku Kyoshitsu, Kyushu Daigaku Nogakubu, Hakozaki, Fukuoka, Japan.

TAPKE, VICTOR F., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Bailey Hall, Ithaca, N. Y.

*TAUBENHAUS, J. J., Division of Plant Pathology and Physiology, Texas Agricultural Experiment Station, College Station, Texas.

TEHON, L. R., Botanist, Natural History Survey of Illinois, 204 Vivarium Building, Champaign, Ill.

TEMPLE, CHARLES EDWARD, Professor of Plant Pathology and State Plant Pathologist, University of Maryland, College Park, Md.

THAXTER, ROLAND, Emeritus Professor of Cryptogamic Botany, Harvard University, 7 Scott Street, Cambridge, Mass.

THIEL, ALBERT FREDERICK, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, College of Agriculture, Lincoln, Nebr.

THOM, CHARLES, Mycologist, Bureau of Chemistry, U. S. Department of Agriculture, 1703 21st Street, N. W., Washington, D. C.

THOMAS, HARVEY EARL, Assistant Professor of Plant Pathology, Cornell University, Ithaca, N. Y.

THOMAS, ROY CURTIS, Associate Pathologist, Ohio Agricultural Experiment Station, Wooster, Ohio.

THOMPSON, NOEL FINLEY, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, State Capitol Annex, Madison, Wis.

THURSTON, HENRY W., JR., Assistant Professor of Plant Pathology, Pennsylvania State College, State College, Pa.

TILFORD, PAUL E., Assistant Pathologist, Agricultural Experiment Station, Wooster, Ohio.

TIMS, EUGENE CHAPEL, Assistant Plant Pathologist, Agricultural Experiment Station, Baton Rouge, La.

TISDALE, LIONEL EARL, General Chemical Company, Laurel Hill Research Laboratory, Laurel Hill, via Maspeth, Long Island, N. Y.

TISDALE, WILLIAM BURLEIGH, Associate Plant Pathologist, University of Florida Tobacco Experiment Station, Quincy, Florida.

TISDALE, WENDELL H., Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

TITUS, E. G., 1228 Bryan Avenue, Salt Lake City, Utah.

TOLAAS, ARNE G., In Charge of Seed Potato Certification, Minnesota Department of Agriculture, University Farm, St. Paul, Minn.

TOMPKINS, CHRISTIAN MILTON, Plant Pathologist, Colorado Agricultural Experiment Station, 803 State Street, Madison, Wis.

TORO, RAFAEL A., Assistant Pathologist, Insular Experiment Station, Rio Piedras, Porto Rico.

TORREY, GEORGE SAFFORD, Assistant Professor of Plant Pathology, Connecticut Agricultural College, Storrs, Conn.

TROST, JOHN FRANCIS, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, 1358 Keston Street, St. Paul, Minn.

TUCKER, CLARENCE MITCHELL, Plant Pathologist, Porto Rico Agricultural Experiment Station, Mayaguez, Porto Rico.

TULLIS, EDGAR C., Fellow in Plant Pathology, University of Nebraska, 1541 N. 28th Street, Lincoln, Nebr.

TURNER, THOMAS WYATT, Head, Department of Biology, Hampton Institute, Hampton, Va.

UPPAL, BADRI NATH, Research Fellow, Iowa State College of Agriculture, Ames, Iowa.

VALLEAU, WILLIAM DORNEY, Associate Professor of Plant Pathology, University of Kentucky, Lexington, Ky.

VAN DER MEER, JIKKE H. H., Botanist, Instituut voor Phytopathologie, Grintweg 93, Wageningen, Holland.

VAN HALTERN, FRANK, Department of Plant Pathology, Iowa State College, Ames, Iowa.

VAN HOOK, J. M., Associate Professor of Botany, Indiana University, Bloomington, Ind.

VAN METER, MARY G., Bureau of Plant Industry, U. S. Department of Agriculture, 1757 K Street, N. W., Washington, D. C.

VANTERPOOL, T. C., Macdonald College, Macdonald College P. O., Quebec, Canada.

†VAUGHAN, R. E., Associate Professor of Plant Pathology, University of Wisconsin, Madison, Wis.

VESTAL, EDGAR F., Des Moines University, Highland Park, Des Moines, Iowa.

VOGEL, IRVIN HENRY, Assistant Manager and Plant Pathologist, J. M. Lupton & Son, Wholesale Seed Growers, Mattituck, N. Y.

VON SCHRENK, HERMAN, Tower Grove and Flad Avenues, St. Louis, Mo.

WAGENER, WILLIS WESTLAKE, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Forest Service, Ferry Building, San Francisco, Calif.

†WAITE, M. B., Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

WALKER, JOHN CHARLES, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, and Assistant Professor of Plant Pathology, University of Wisconsin, Madison, Wis.

WALKER, LEVA BELLE, Associate Professor of Botany, University of Nebraska, Lincoln, Nebr.

WALKER, MARION N., Ingenio Jobabo, Oriente, Cuba.

WALLACE, ERRETT, Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

WALLACE, J. M., Assistant Plant Pathologist, Mississippi Agricultural and Mechanical College, Box 95, A. and M. College, Miss.

WALTON, RICHARD CHAMBERS, Associate Professor of Plant Pathology, Pennsylvania State College, Arendtsville, Adams County, Pa.

WATERHOUSE, WALTER LAWRY, Lecturer in Plant Pathology, University of Sydney, Faculty of Agriculture, Sydney, New South Wales.

WATERMAN, ALMA MAY, Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Brown University, Providence, R. I.

WATERS, CHARLES W., Acting Assistant Professor of Botany, Miami University, Oxford, Ohio.

WEBB, R. W., Department of Plant Pathology, University of Wisconsin, Madison, Wis.

*WEBER, GEORGE F., Associate Plant Pathologist, Florida Agricultural Experiment Station, Gainesville, Florida.

WEHMEYER, LEWIS E., 1020 Michigan Avenue, Ann Arbor, Mich.

WEIMER, JAMES LEROY, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

WEINRICH, WM., JR., Box 2713, Honolulu, Hawaii.

WEIR, JAMES ROBERT, Plant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

WEISS, FREEMAN, Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

WELCH, DONALD STUART, Instructor, New York State College of Agriculture, Ithaca, N. Y.

WELLMAN, FREDERICK L., Assistant in Plant Pathology, University of Wisconsin, Madison, Wis.

WENIGER, WANDA, Plant Pathologist, North Dakota Experiment Station, Agricultural College, N. Dak.

WEST, ERDMAN, State Plant Board, Box 196, Gainesville, Fla.

WESTCOTT, CYNTHIA, Instructor in Plant Pathology, Cornell University, Bailey Hall, Ithaca, N. Y.

WESTON, WILLIAM H., Assistant Professor of Botany, Harvard University, 20 Divinity Avenue, Cambridge, Mass.

†WHETZEL, HERBERT HICE, Professor of Plant Pathology, Cornell University, Bailey Hall, Ithaca, N. Y.

WHITE, RICHARD PEREGRINE, Assistant Plant Pathologist and Assistant Professor of Plant Pathology, Kansas State Agricultural College, Manhattan, Kansas.

WHITNEY, WILL A., Senior Scientific Aid, Bureau of Plant Industry, U. S. Department of Agriculture, 1736 G Street, N. W., Washington, D. C.

WIANT, JAMES STEWART, Fellow in Plant Pathology, Cornell University, 214 Thurston Avenue, Ithaca, N. Y.

WILCOX, RAYMOND BOORMAN, Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Ohio Agricultural Experiment Station, Wooster, Ohio.

WILSON, EDWARD ELMER, Student Assistant in Plant Pathology, University of Wisconsin, Madison, Wis.

WILSON, GUY WEST, Professor of Biology, Upper Iowa University, Fayette, Iowa.

WILSON, ORVILLE TURNER, Associate Professor of Botany, University of Cincinnati, Cincinnati, Ohio.

WINELAND, GRACE O., Department of Plant Pathology, University of Wisconsin, Madison, Wis.

WINGARD, SAMUEL ANDREW, Associate Plant Pathologist, Virginia Agricultural Experiment Station, Blacksburg, Va.

WINSTON, J. R., Associate Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

*WOLF, FREDERICK ADOLPHUS, Pathologist, Office Fruit Disease Investigations, U. S. Department of Agriculture, Fruit Disease Laboratory, Orlando, Fla.

WOOD, JESSIE I., Junior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

†WOODS, ALBERT FRED, President, University of Maryland, College Park, Md.

WOOLMAN, HORACE M., Newman, Calif., (Star Route).

YORK, H. H., Forest Pathologist for the State of New York, New York Conservation Commission, Albany, N. Y.

YOUNG, HARRY CURTIS, Chief, Department of Botany and Plant Pathology, Ohio Agricultural Experiment Station, Wooster, Ohio.

*YOUNG, PAUL ALLEN, Department of Botany and Bacteriology, Agricultural Experiment Station, Bozeman, Mont.

YOUNG, VIVE HALL, Professor of Plant Pathology, University of Arkansas, and Plant Pathologist, Arkansas Experiment Station, Fayetteville, Ark.

ZELLER, SANFORD M., Plant Pathologist, Oregon Experiment Station, Corvallis, Oregon.

ZUNDEL, GEORGE LORENZO, Extension Plant Pathologist, State College of Washington, Pullman, Wash.

In Memoriam

	Elected	*Died*
BAIN, S. M. (Charter Member)	1908	1919
BELL, A. T.	1914	1919
BESSEY, CHARLES E. (Charter Member)	1908	1915
CARLETON, MARK H. (Charter Member)	1908	1925
CLARKIN, J. H.	1911	1913
CRITTENDEN, CHARLES G.	1915	1918
DURAND, E. J.	1911	1922
ELLIOT, JOHN A.	1916	1923
FARLOW, W. G. (Charter Member)	1908	1919
HALSTED, BYRON D. (Charter Member)	1908	1918
HENDERSON, MARTIN P.	1912	1923
JONES, W. RALPH	1911	1915
KURTZWEIL, C. E.	1919	1921
LAIRD, K. B.	1915	1919
MCMURRAN, S. M.	1911	1920
MARTIN, W. A.	1914	1916
OBERLY, EUNICE R.	1919	1921
POND, R. H.	1911	1911
PUTTICK, G. F.	1919	1923
RAVN, F. KÖLPIN	1911	1920
RIDDLE, LINCOLN W.	1919	1921
ROARK, E. W.	1914	1918
ROSENBAUM, JOSEPH	1911	1925
SELBY, A. D. (Charter Member)	1908	1924
STEWART, V. B. (Charter Member)	1908	1918
TAYLOR, ROSE M.	1918	1918
THOMAS, M. B. (Charter Member)	1908	1912
VASEY, H. E.	1917	1918
WERKENTHIN, FRED C.	1915	1922
YOUNG, YOUNGEN	1914	1916